



EIGHTH AIR FORCE



TACTICAL DEVELOPMENT

AUGUST 1942—MAY 1945





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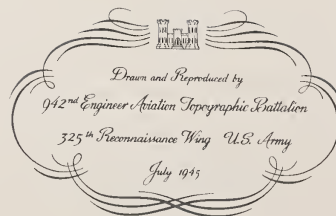
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Eighth Air Force
TACTICAL DEVELOPMENT
August 1942 - May 1945

Prepared by
Eighth Air Force
and
Army Air Forces Evaluation Board
(European Theater of Operations)

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Drawn and Reproduced by

942nd Engineer Aviation Topographic Battalion

325th Reconnaissance Wing U.S. Army

July 1945

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FOREWORD

In a Directive dated 26 November 1944 Lieutenant-General James H. Doolittle, then Commanding General, Eighth Air Force requested a report of the development of the Eighth Air Force for the Commanding General, Army Air Forces and to be used as a background for tactical study by the Air Force Tactical School.

This report, "Eighth Air Force - Tactical Development - August 1942 - May 1945" was prepared under the direction of Major General Orvil A. Anderson, former Deputy Commander for Operations, Eighth Air Force.

It is believed that the report is sound in its statements and conclusions, and that it offers valuable information to anyone reviewing the combat activities of the Eighth Air Force during the air war against Germany.


W. E. KEPNER,
Major General USA
Commanding General, Eighth Air Force

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Eighth Air Force
TACTICAL DEVELOPMENT
August 1942 - May 1945

CONTENTS

- Chapter I - The Development of Basic Bomber Formations and Procedures.
- Chapter II - The Development of Basic Fighter Formations and Procedures.
- Chapter III - Bombing.
- Chapter IV - Targets.
- Chapter V - The Air War on the Western Front, 1942 - 1945.

- Appendix "A" - Development of the Organization.
- Appendix "B" - Major Modifications to Aircraft and Equipment.

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ILLUSTRATIONS

CHAPTER I

	Page
Separate Squadrons of 6 a/c each (August, 1942)	4 & 5
18 a/c Group (September, 1942)	7 & 8
36 a/c Group (September, 1942)	10 & 11
Individual Groups of 18 a/c each Javelin of Groups (December, 1942)	13 & 14
Individual Groups of 18 a/c each Wedge of Groups (February, 1943)	16 & 17
Combat Wing of 3 Groups of 3 Squadrons of 6 a/c each (Flown from March, 1943 to April, 1943 in 1st and 3rd Divisions)	19
3 Combat Wings of 54 a/c each (March, 1943)	20
More Compact Combat Wing of 54 a/c each 3 Groups of 3 Squadrons of 6 a/c each (April to December, 1943)	22, 23 & 24
The 36 a/c Group (January, 1944)	26 & 27
The 36 a/c Group, 4 Squadrons, 9 a/c each (February - April, 1945)	29 & 30
The 27 a/c Group, 3 Squadrons, 9 a/c each (Flown by 2nd Air Division February - April, 1945)	32 & 33
The 27 a/c Group - 3 Squadrons, 9 a/c each (Flown by 96th Combat Wing February - April, 1945)	35 & 36
Eighth Air Force Group Assembly Areas	38
Procedure at IP for Bomb Run	39
Group Assembly through Overcast	41
Detail Plan of Group Assembly	42
Wing and Division Assembly	43
Route to Target and Rally Point	44
Group Maneuver at Initial Point and at Rally Point	45
Route Out from Rally Point	46
Air Force Dispersion to Individual Airdromes	47
Group Landing Procedure at Base	48

CHAPTER II

Fighter Escort-Battle Formation - Plan View	51
Basic Type of Escort Employing 3 Fighter Squadrons	53 & 54

Page

Basic Type of Escort Employing 3 Fighter Squadrons	55
Basic Type of Escort Employing 1 Fighter Squadron	55
Strafing - Part 1	57
Strafing - Part 2	58
Strafing - Part 3	59

CHAPTER III

Tons of Bombs Dropped on Various Target Categories	63
Accuracy of Visual Bombing and Percentage Dropped by Visual and Overcast Methods	63
H2X is Airborne Radar	66
Bombing (Deflection-range)	67
Navigation	68
Sorties and Effective Sorties Flown by H2X during 1944	69
Bombardment Groups Equipped with H2X during 1944	69
Percentage Serviceability Over Target of H2X during 1944	69
Gee-H Scope Just Before "Bombs Away"	70
Distribution Within 0 to 1 Miles of Aiming Point	72
Distribution Within 0 to 5 Miles of Aiming Point	72
Number of Days by Months, on Which Targets Were Attacked by Eighth Air Force	73

CHAPTER IV

Estimated Oil Production in German Controlled Territory	77
Axis Gasoline Producers, 1 April 1944, Chart A	79
Axis Oil Producers, 1 April 1944, Chart B	79
German S/E Fighter Assembly Plants, 1 August 1943	80
German S/E Fighter Assembly Plants, 1 February 1944	80
German S/E Fighter Assembly Plants, 1 August 1944	81
Axis Ball Bearing Plants, 1 August 1943	81

CHAPTER V

Flak Chart, 26 September 1943, Chart A	87
Flak Chart, 23 February 1945, Chart B	87

	<u>Page</u>
Operational Efficiency of Bombers, Chart A	91
B-17 Penetrations Into Enemy Territory Chart B	91
Certain Individual Losses Compared to Average Daily Losses, Chart A	93
Certain Individual Losses as a Percentage of Aircraft Bombing, Chart B	93
Operational Efficiency of Fighters, Chart A	95
Number of Operational Fighters Monthly by Types, Chart B	95
P-47 Escort Ranges, Chart A	97
P-51 and P-38 Escort Ranges, Chart B	97
Effectiveness of Enemy Fighters, Chart A	99
Armament of Enemy Fighters, Chart B	99
Strength of German Air Force on Western Front, Chart A	101
Production of Fighters for German Air Force, Chart B	101
Enemy Aircraft Destroyed in Combat, Chart C	101
Distribution of German Fighters by Fronts: Single Engine Fighters, Chart A	103
Twin Engine Fighters, Chart B	103
Major Enemy Industrial Areas, Chart A	105
A few Major Targets, Chart B	105
Enemy Single Engine Fighter Disposition, August 1942, Chart A	107
Range Capability, 17 August - 11 December 1942, Chart B	107
Mission to Lille, 9 October 1942: Penetration, Chart A	109
Withdrawal, Chart B	109
Enemy Single Engine Fighter Disposition, 1 January 1943, Chart A	111
Range Capability, 12 December 1942 - 24 July 1943, Chart B	111
Mission of 13 June 1943 to Kiel and Bremen	113
Mission of 22 June 1943 to Huls	115
Mission of 28 June 1943 to St. Nazaire	117

	<u>Page</u>
Enemy Single Engine Fighter Disposition 1 August 1943, Chart A	119
Range Capability, 25 July 1943 - 19 February 1944, Chart B	119
Mission to Marienburg, 9 October 1943	121
Mission to Munster, 10 October 1943	123
Mission of 14 October 1943 to Schweinfurt	125
Enemy Day Fighter Disposition, 1 March 1944, Chart A . .	127
Range Capability, 20 February 1944 - 20 June 1944, Chart B	127
Mission to Leipzig, 20 February 1944	129
Mission to Merseburg, 12 May 1944	132 & 133
Enemy Fighter Disposition, 1 July 1944, Chart A	135
Range Capabilities, 21 June 1944 - 8 May 1945, Chart B.	135
Mission to Leuna, 11 September 1944	136
Mission 27 November 1944, Fighter Attack	138 & 139
Mission to Berlin, 5 December 1944	140
Enemy Fighter Disposition, 1 January 1945, Chart A . .	141
Enemy Fighter Disposition, 1 May 1945, Chart B	141

APPENDIX A

Schematic Organization of the Eighth Air Force as of 22 May, 1942	2-A
Organization of the Eighth Air Force on Date of First Independent Combat Mission	4-A
Organization of the Eighth Air Force During the First Month in Which a Total of 1000 Bombers Were Dispatched Against German Occupied Europe . . .	6-A
Station Organization (typical) Showing Command and Line Organization in the Spring of 1943	8-A
Organization of the Eighth Air Force At the Time of the Invasion of Italy	10-A
Organization of the Eighth Air Force After Formation of U.S.S.T.A.F. in Preparation for Continental Invasion	12-A
Organization of the Eighth Air Force Four Months after Invasion of Continent	14-A

15 MARCH 1945

HIGH FIGHTER
COVER 3,000 ft
above BOMBERS

FIGHTER COVER
1,500 ft to 2,000 ft
above BOMBERS

FIGHTER COVER
1,000 ft. to 1,500 ft
above BOMBERS

Fighter Groups on Supporting Sweeps

1st AIR DIVISION

HIGH Fighter Cover

ROCKETS

FLAK, RED and
PINK BURSTS

Front Cover

F L A K

Fighter Sweep
to SIDE

fighters Sweeping 5 miles ahead and slightly above
2nd Air Division

Rear Cover

SIDE Fighter Cover

3rd AIR DIVISION

FLAK

FLAK

5/10 cloud
over Target area

3/10 cloud
to North of
Target area

2nd AIR DIVISION

8 - 10/10 CUMULUS and STRATOCUMULUS, Base 1 - 2,000 ft., Top 7 - 9,000 ft..

Enemy Twin Jet A/c
Rising to attack from
ORANIENBURG A/F

Gun Emplacements
around Target area.

Oranienburg
A/F

1944

1944

1944

1944

1944

1944

1944

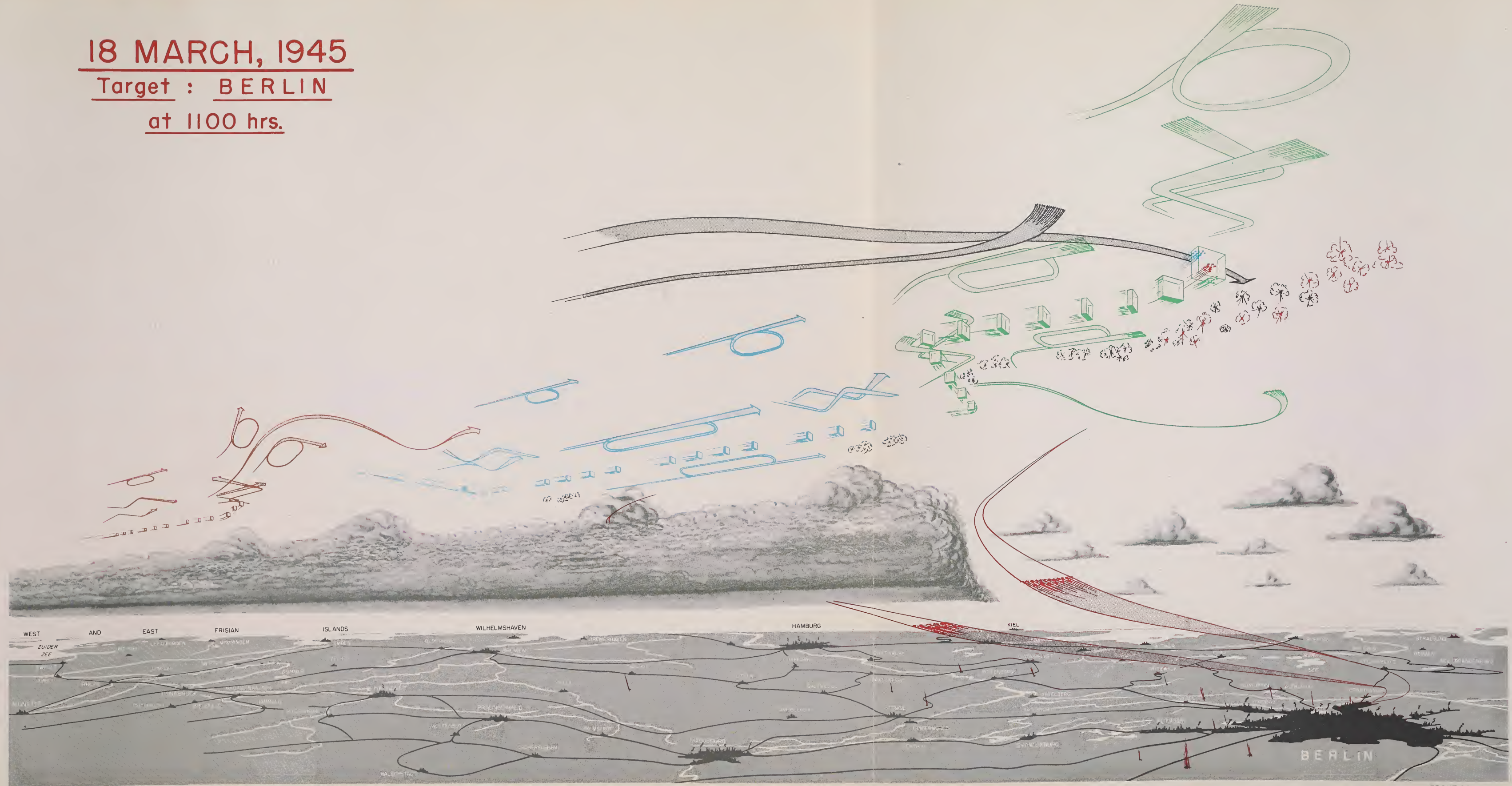
1944

1944

18 MARCH, 1945

Target : BERLIN

at 1100 hrs.



CHAPTER I

THE DEVELOPMENT OF
BASIC BOMBER FORMATIONS
AND
PROCEDURES

THE PROBLEM

The original objective of formation flying by bombers was to concentrate sufficient fire power to permit the formation to fly anywhere in spite of enemy fighter attacks. The vital difference in viewpoint of the American bomber force from that of other nations was its emphasis on security of the force. To continue pressure on the enemy, our bomber force must be able to fly to-day, to-morrow and the next day. Without ample defense, we would take losses which might force our bombers to fly at night for security, thus losing all the advantages which would accrue from daylight bombing attacks.

Although security of force was the dominant factor in these formations, other vital factors were involved in flying any formation: bomb pattern, visibility, flexibility, ease of flying, and ability to be commanded in the air. Every new formation had to be analysed for its adequacy in all these respects.

By the fall of 1943, it became obvious that no new formation could develop sufficient defense to enable the force to venture unescorted deep into Germany where our choice targets lay. Enemy tactics had improved; new German armament out-ranged our .50 calibre machine guns. The rocket mortar mounted on twin-engined fighters, was lethal beyond the range of our guns. Much needed fighter escort of long range was soon to make its appearance.

With the advent of these long-range fighters, the development of bomber formations proceeded toward quite different objectives. Now the need was to develop a formation which:

- (1) could be escorted readily,
- (2) would break down easily into units giving a better bomb pattern, and
- (3) would permit the passage of a number of units so rapidly over an area of heavy flak defense that the anti-aircraft guns could fire on only a few of the units.

The charts and pictures following illustrate the developments in formation flying, first, to gain fire power for defense against enemy aircraft and, later, to improve escorting capabilities, the bomb pattern, and the defense against flak. The formations shown indicate the general trend; but commanding officers of units had leeway to experiment and make changes in formation as they gained experience in battle.

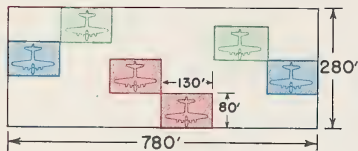
DIAGRAM 1 - SEPARATE SQUADRONS OF 6 A/C EACH (AUGUST 1942)

On 17 August 1942 Eighth Air Force dispatched its first formation against Fortress Europe - one of two squadrons (each of 6 aircraft) flying a couple of miles apart. This separation range did not permit mutual fire support. Spitfires furnished top cover for the round trip to Rouen and return.

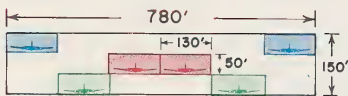
Succeeding operations saw up to four such squadrons flying wide apart. These were covered by Spitfires except on the missions down to St. Nazaire and Lorient in which bombers outranged their Royal Air Force escort.

This initial formation had the advantage of flexibility, but could only bring a small number of guns to bear on each attacking enemy aircraft.

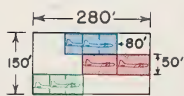
DIAGRAM I



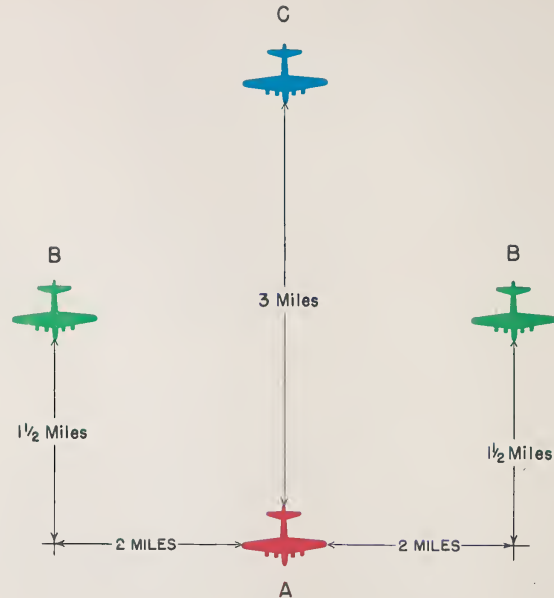
PLAN of SQUADRON



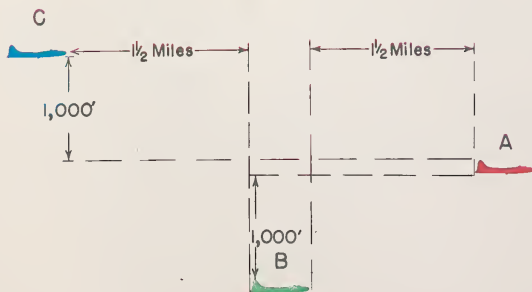
FRONT ELEVATION of SQUADRON



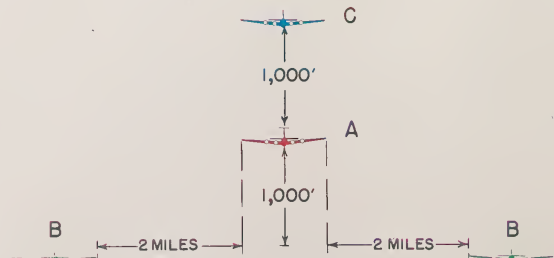
PROFILE of SQUADRON



PLAN of GROUP



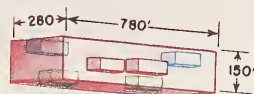
PROFILE of GROUP



FRONT ELEVATION of GROUP

DIAGRAM I

Separate Squadrons of 6 A/c each (August 1942)



SQUADRON 6 A/c

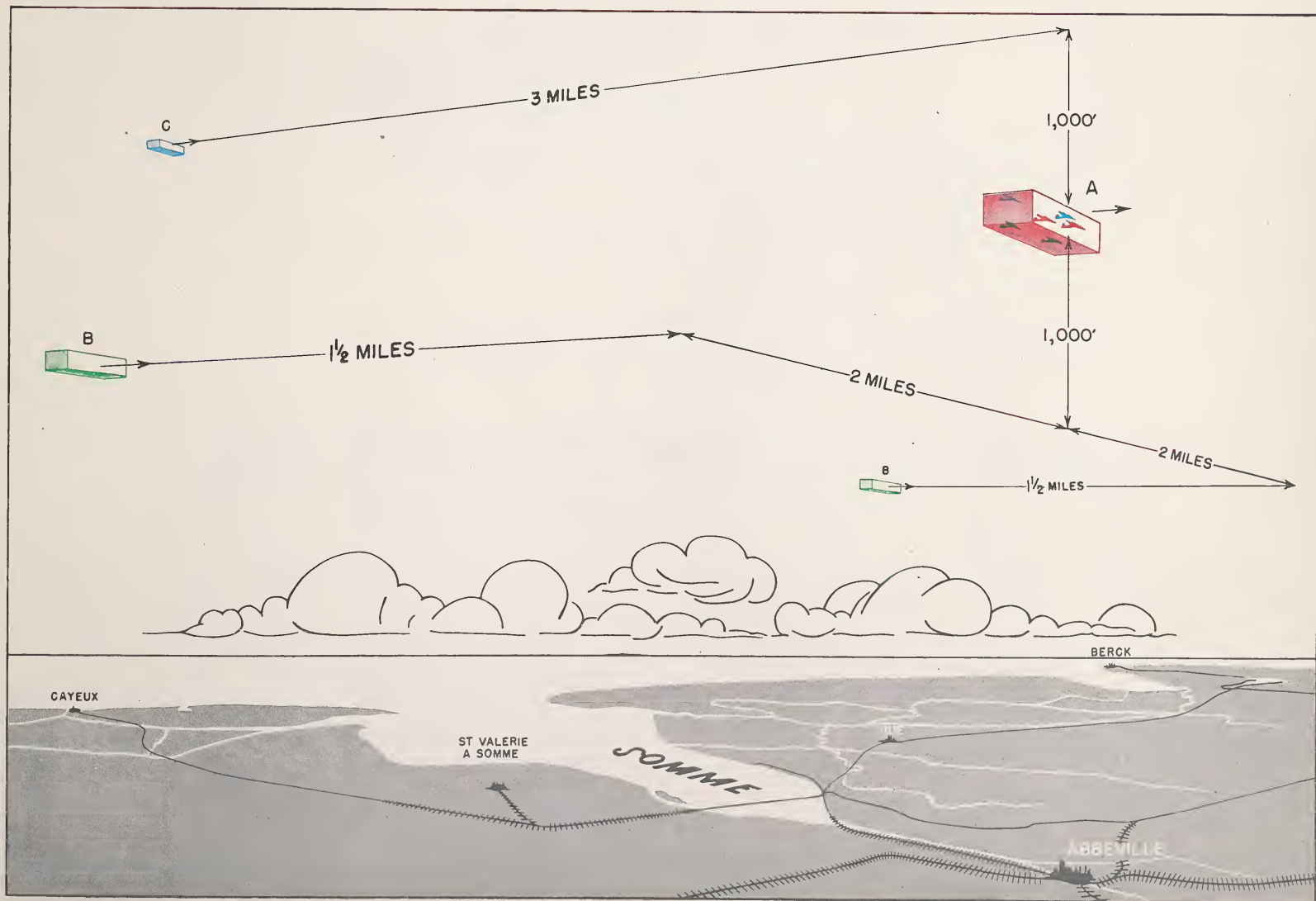


DIAGRAM 2 - 18A/C GROUP (SEPTEMBER 1942)

At a time when Germany's U-boat campaign was inflicting mounting losses on Allied shipping, the Eighth Air Force increased its penetration and ventured beyond escort range to attack submarine bases in France, Holland and Belgium.

Growing aggressiveness of the Luftwaffe dictated compression of the previous loose formation of four squadrons, in order to make possible mutual support and more concentrated fire power. Air commanders experimented with two basic formations, the 18 aircraft group (Diagram 2) and the 36 aircraft group (Diagram 3).

The 18 aircraft group consisting of two boxes of 9 aircraft each, was designed to permit better control of more aircraft. Each squadron was a "V" of 3 elements, and each element a "V" of 3 aircraft. The 9 aircraft in each squadron flew at the same altitude with the wing elements in trail of the lead element. The second squadron of 9 aircraft flew 500 feet above the first, slightly in trail and echeloned away from the sun.

Although this formation was more compact than the original "Rouen" formation, it had less flexibility. On turns, wing aircraft lost sight of those toward the center of the formation during completion of the maneuver. Because unstacked elements blocked out each other's field of fire, vulnerability to German Air Force attacks at certain times was increased.

DIAGRAM 2

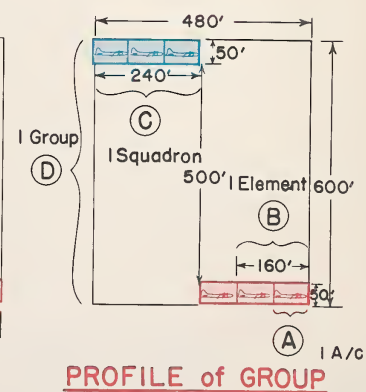
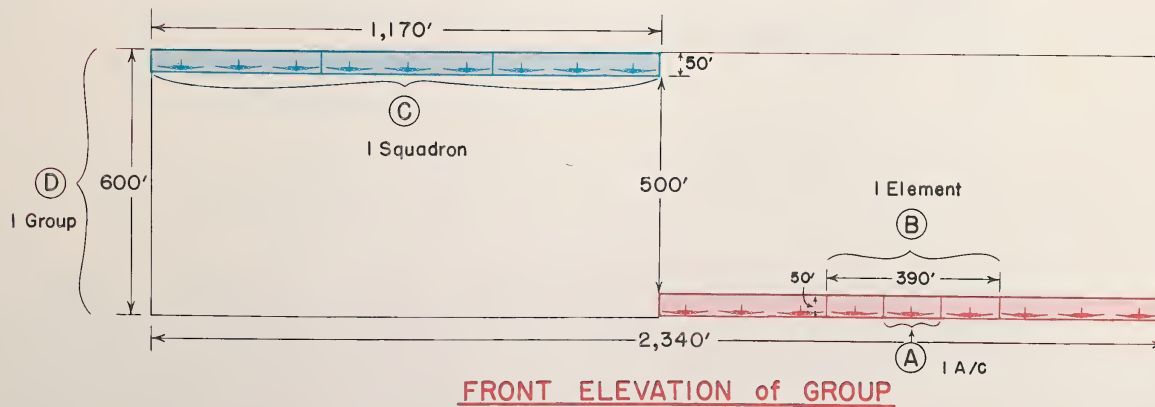
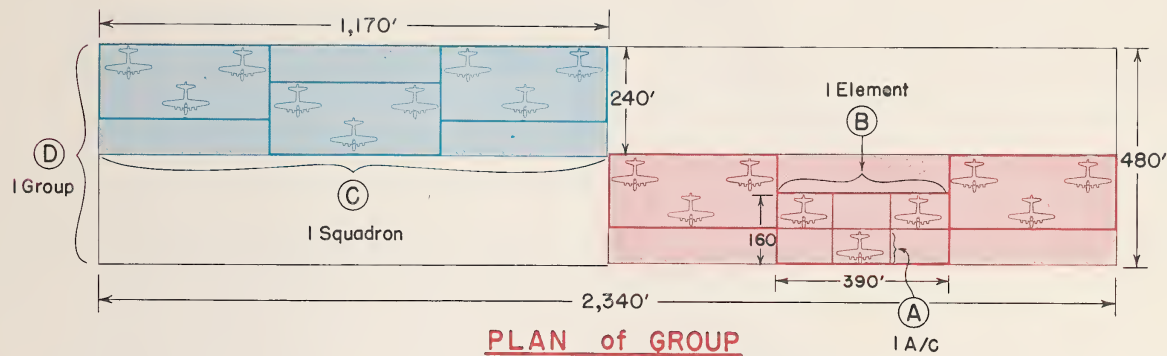
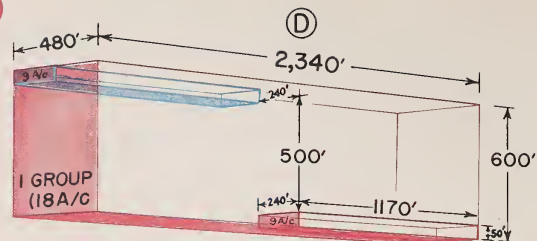
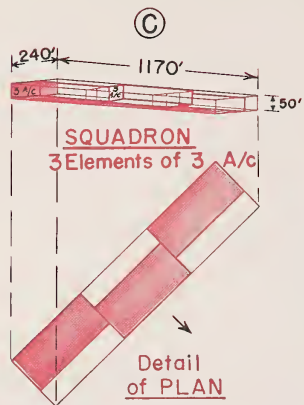
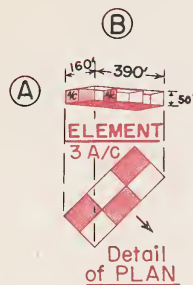


DIAGRAM 2

18 A/c GROUP (September 1942)



18 A/c GROUP
2 Squadrons of 9 A/c

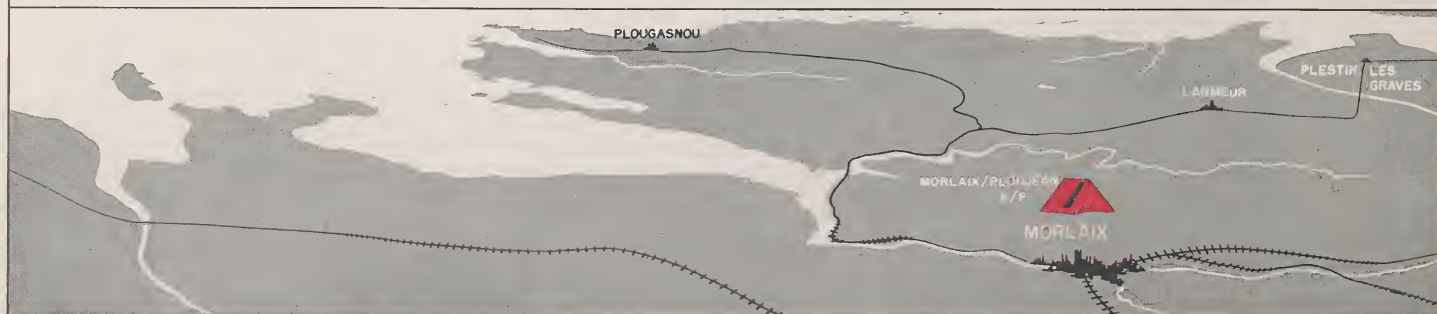
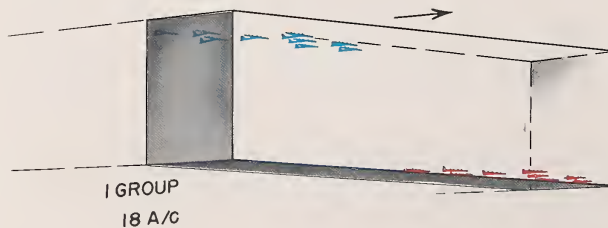


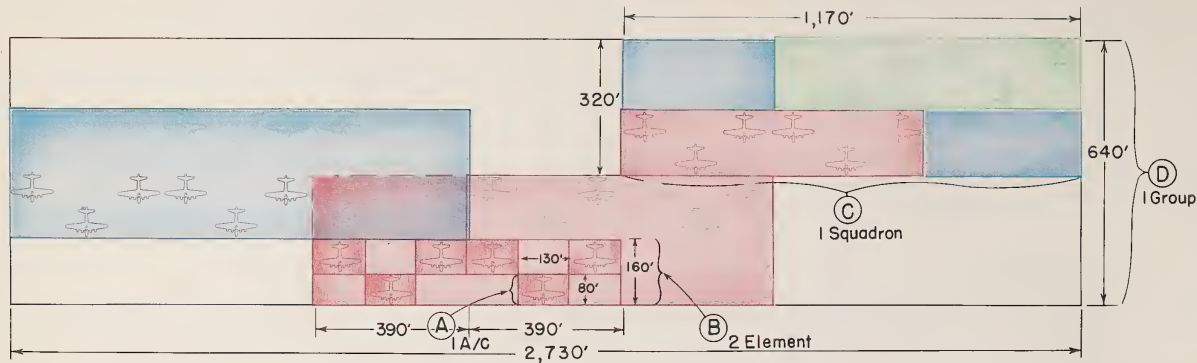
DIAGRAM 3 - 36 A/C GROUP (SEPTEMBER 1942)

This alternate formation was a further step in the direction of unified control. It had 3 units of 12 aircraft each, with each unit broken down into 4 elements of 3 aircraft each. Inner aircraft were protected but the formation did not solve the problem of flexibility, nor did it increase fire-power. Also, it was difficult to fly. The two trailing elements were required to be abreast of each other with all 6 aircraft at an elevation 80 feet below the lead elements. These elements were echeloned toward the sun from the lead elements.

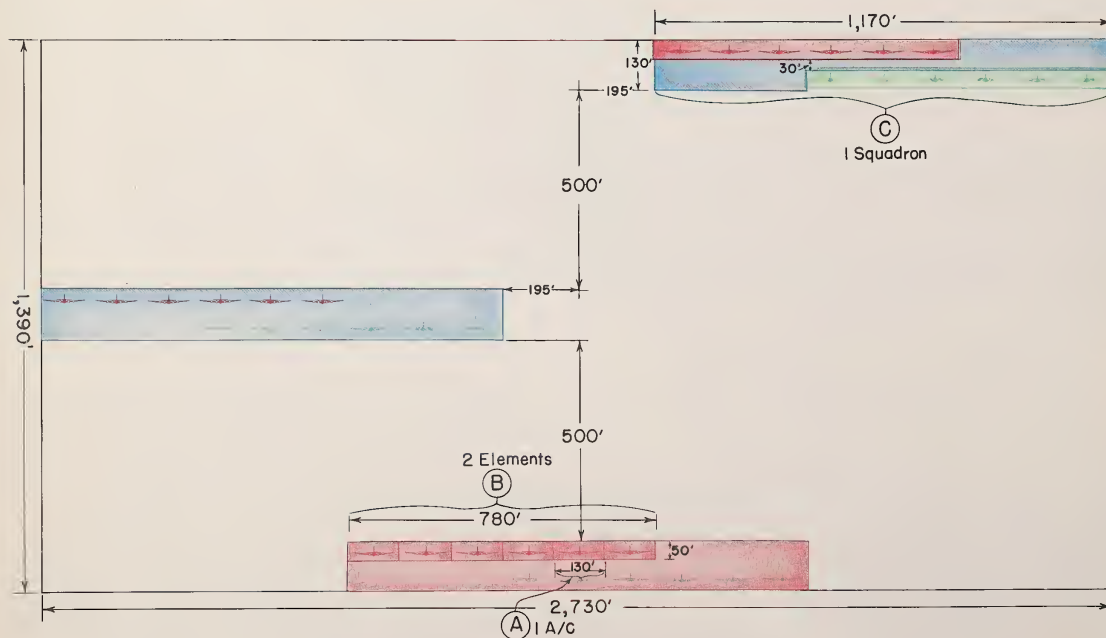
The formation did, however, solve in overall fashion the problem of staggering. In such a 36 aircraft group, three units of 12 aircraft each flew in a staggered formation, a lead unit, followed by a wing unit to the side and 500 feet above the lead; then the other wing unit still further behind at the opposite side and 1,000 feet above the lead.

Although this type of formation kept as tightly closed as possible, the lead aircraft flew out of the line of vision of many units, and this made a cohesive formation virtually impossible.

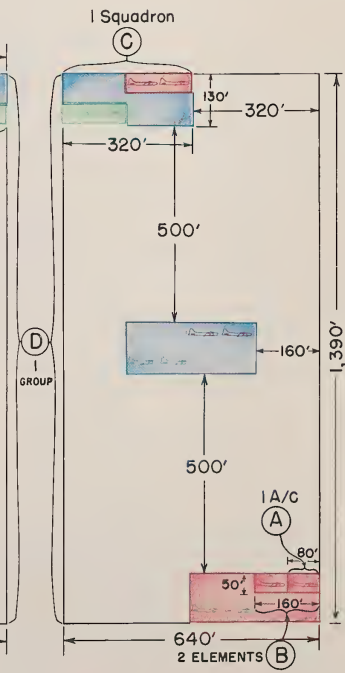
DIAGRAM 3



PLAN of GROUP



FRONT ELEVATION of GROUP



PROFILE of GROUP

DIAGRAM 3

36 A/c GROUP (September 1942)

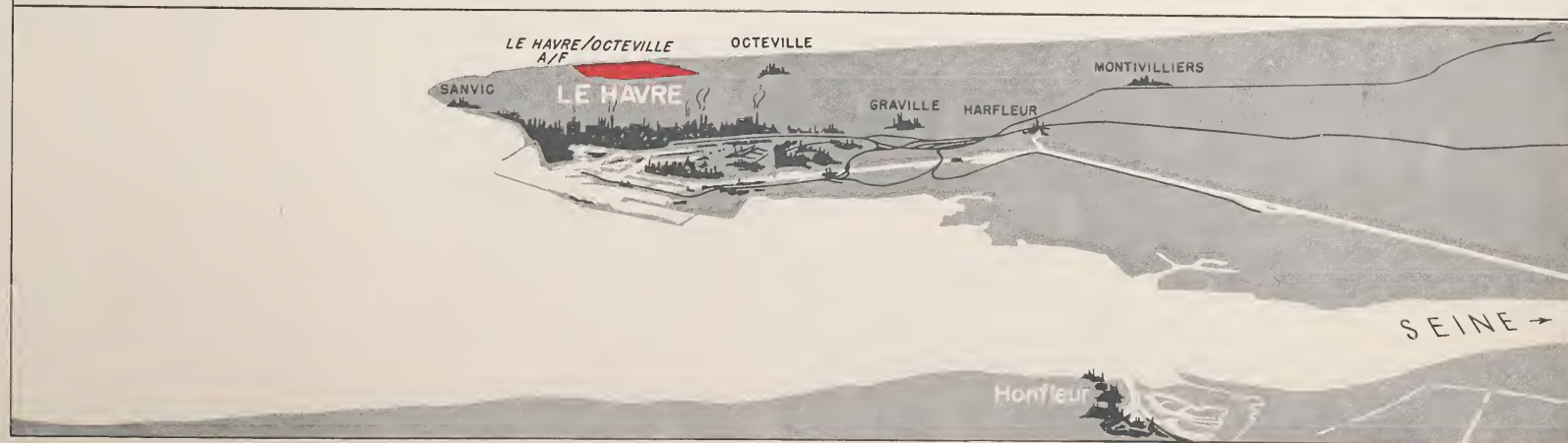
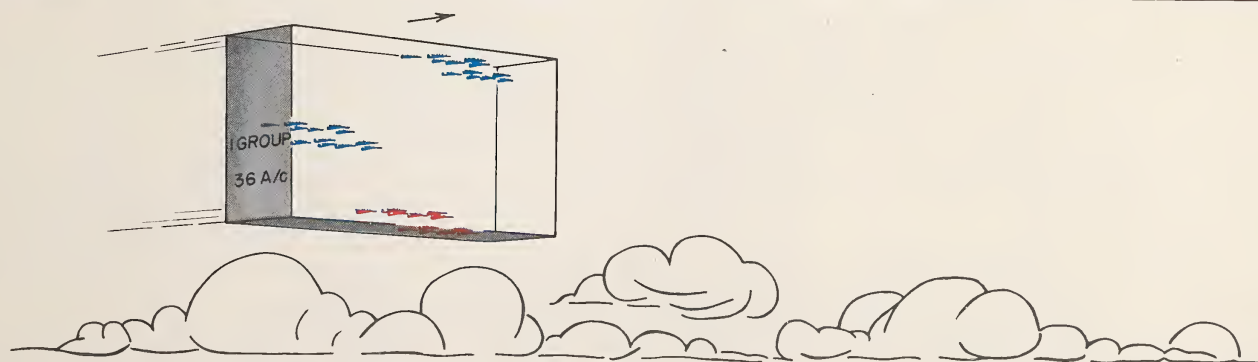
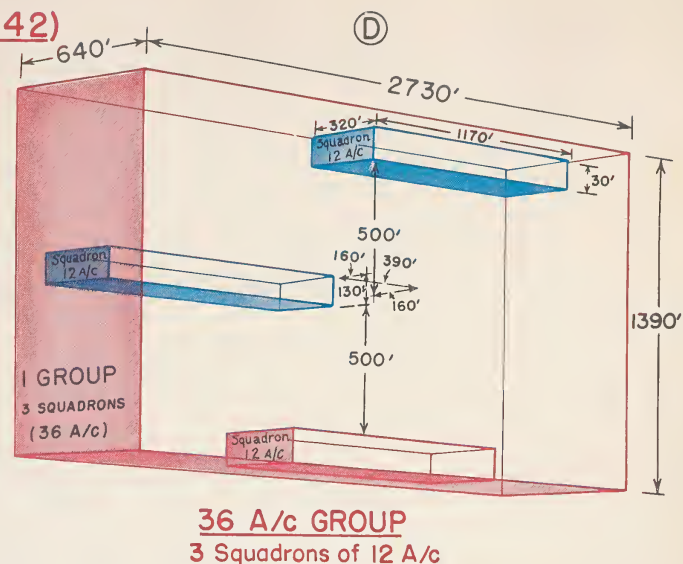
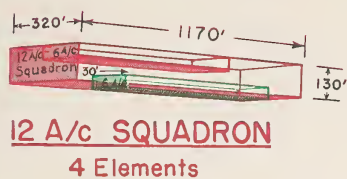
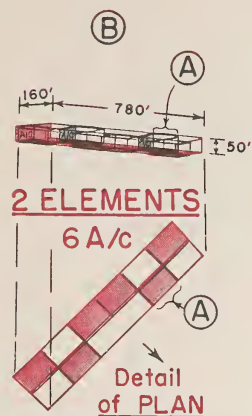


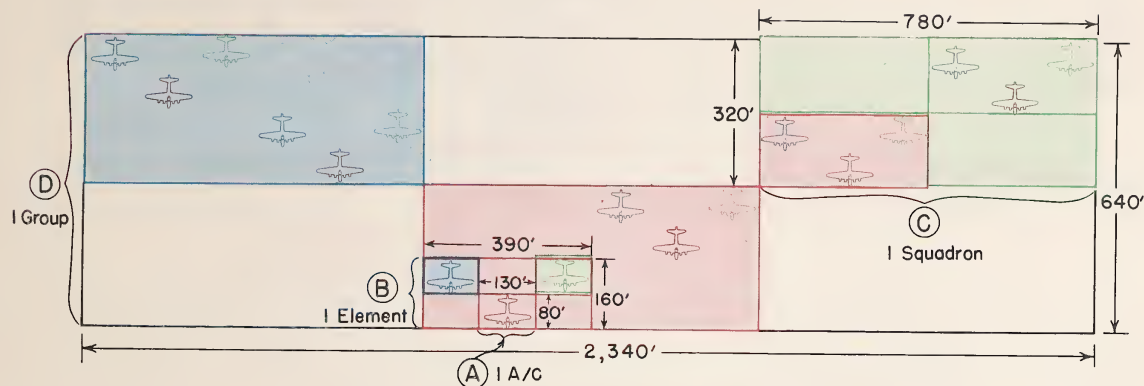
DIAGRAM 4 - JAVELIN OF GROUPS OF 18 A/C EACH (DECEMBER 1942)

Numerical growth of the Eighth Air Force began to increase the capability of attacking more targets and penetrations went as deep as Romilly and Wilhelmshaven. But this extended time of exposure to enemy fighter attacks. It should be remembered that at this time bomber formations still relied primarily on their own fire-power for defense against the German Air Force. Therefore, the development of a formation affording an absolute maximum of mutual fire support was vital.

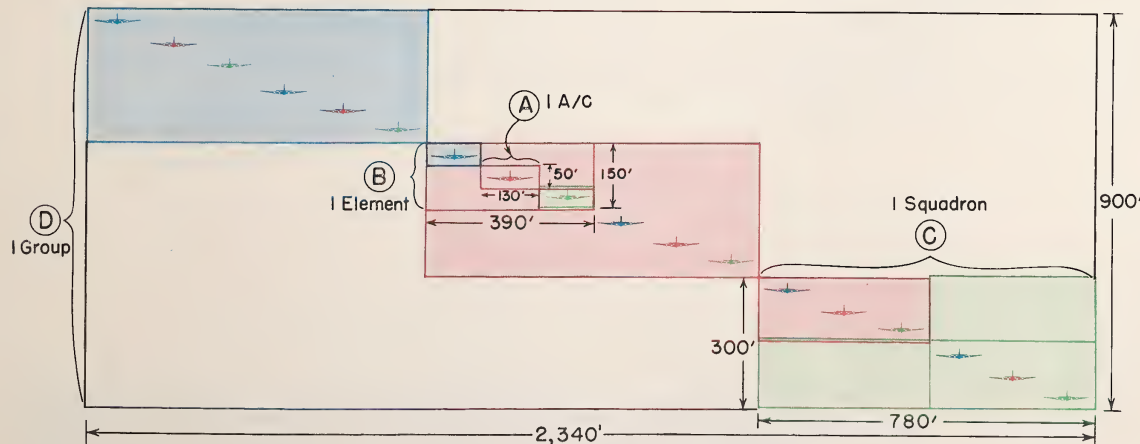
The first standardized javelin formation appeared in December 1942. It consisted of three squadrons - lead, high, and low. Squadrons comprised two elements in echelon, each element stacked toward the sun, with elements and squadrons similarly stacked. This change increased flexibility over the previous 36 aircraft formation, and brought greater fire-power to bear within each group, but it did not significantly help forward fire-power. The Luftwaffe exploited the vulnerability of the lightly defended nose of our aircraft, causing losses of 10 percent and 12 percent by mid-winter. Attempting to deny the enemy his best line of attack, groups were flown in trail, stacked above and behind the lead group and echeloned toward the sun. The groups became separated beyond the range of mutual fire-support, but at least column effect provided some denial to the enemy's freedom of attack.

The chief disadvantage was difficulty of flying this formation. Stacking in trail at increasing altitudes, caused troublesome speed differentials between high and low groups with resultant "stringing-out". Abortives mounted as individual bombers were unable to remain in formation, and mutual support became increasingly difficult. The addition of a fifth group to the Air Force made it necessary to discard this javelin formation.

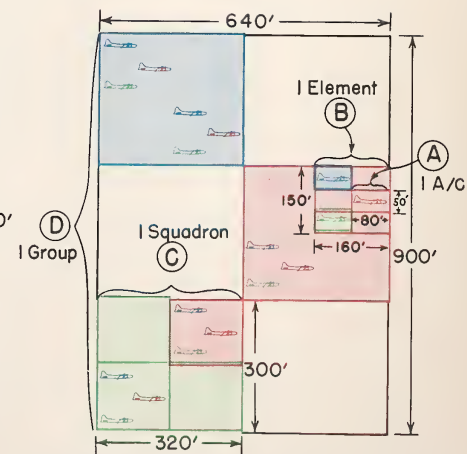
DIAGRAM 4



PLAN of GROUP



FRONT ELEVATION of GROUP



PROFILE of GROUP

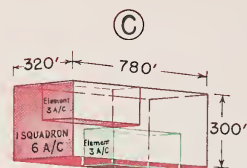
DIAGRAM 4

Individual Groups of 18 A/c each (December 1942)

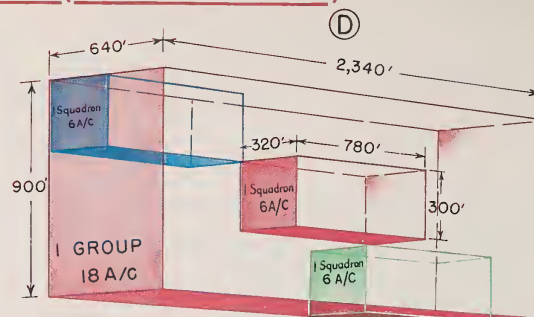
JAVELIN of GROUPS



①
ELEMENT
3 A/c



SQUADRON
2 Elements of 3 A/c



18 A/c GROUP
3 Squadrons of 6 A/c

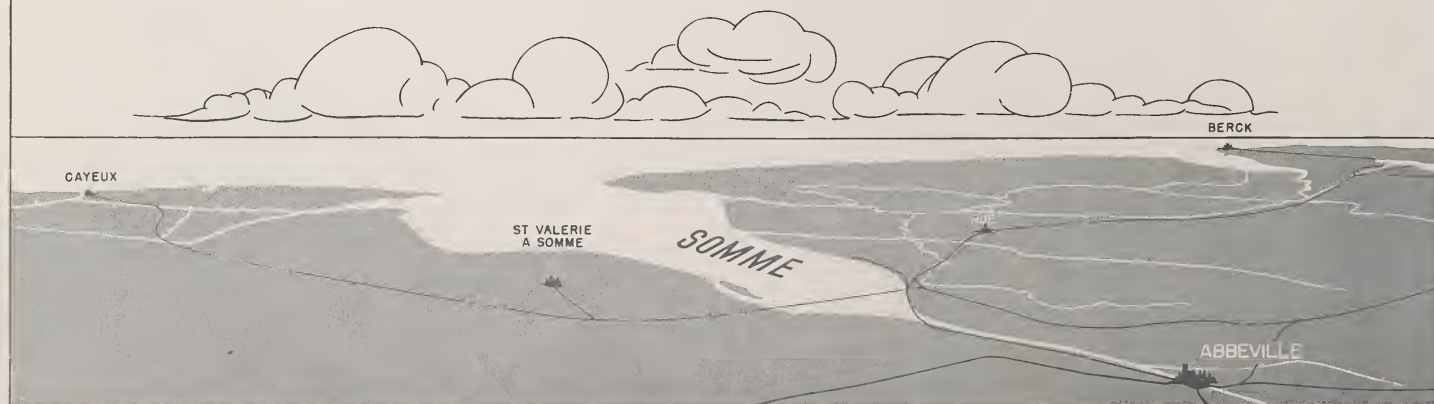
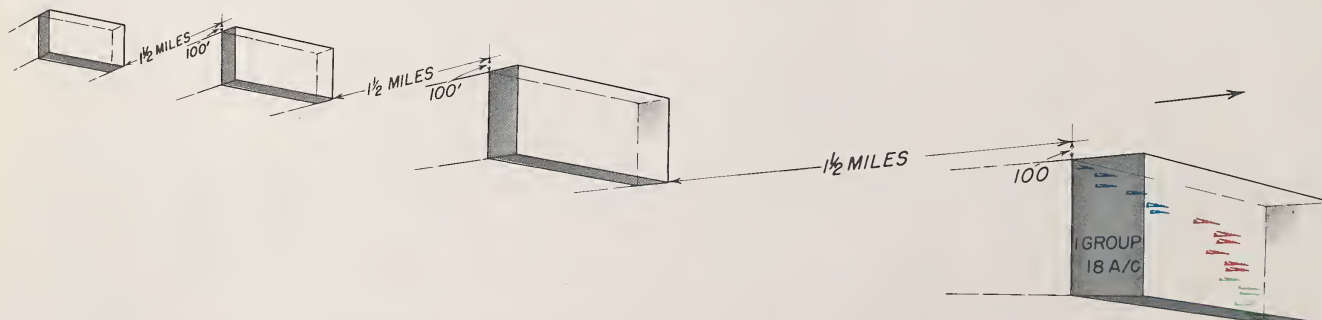


DIAGRAM 5 - WEDGE OF 5 GROUPS (FEBRUARY 1943)

The wedge formation replaced the javelin in an attempt to stop "stringing-out" in column. The lead group was placed in the center of this formation with two groups stacked above in echelon and two groups stacked below in opposite echelon. Aircraft, squadrons, and groups were all stacked in the same direction.

This formation considerably shortened the column but did not entirely overcome a tendency to "string-out" caused by a difference in altitude between high and low groups. What it did do was to reduce the speed differential between lead and trailing groups, by placing the leader at mid-altitude.

Also, by increasing forward fire-power it reduced somewhat the vulnerability to nose attacks and thus favored mutual support. However, analysis of losses revealed that still more compression was necessary to counter the devastating nose attacks, and experiments were begun in order to increase forward fire-power. The resulting formation appears in Diagram 6.

DIAGRAM 5

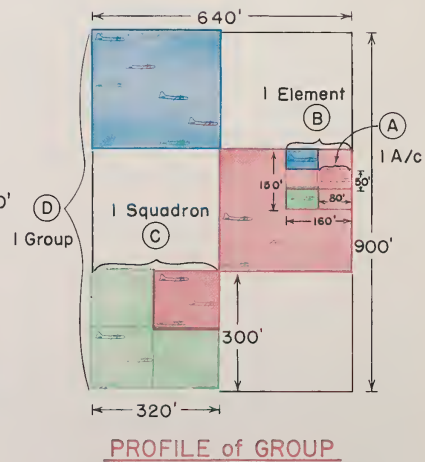
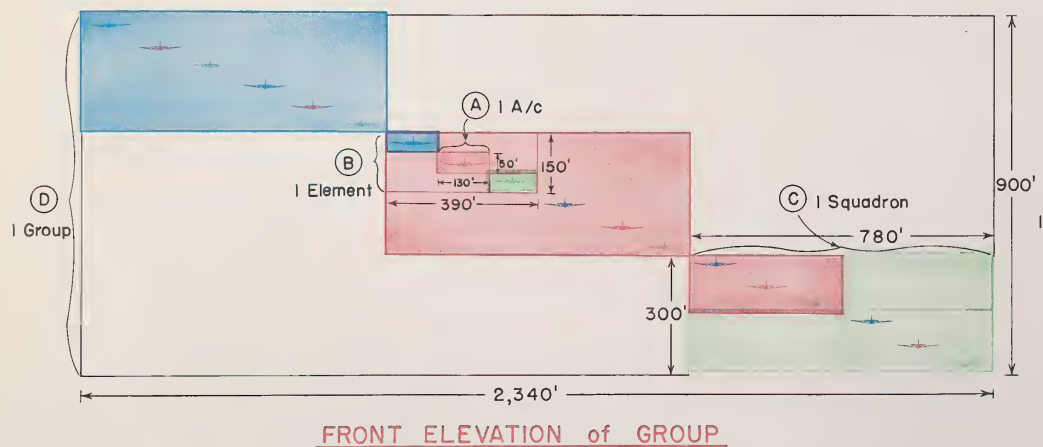
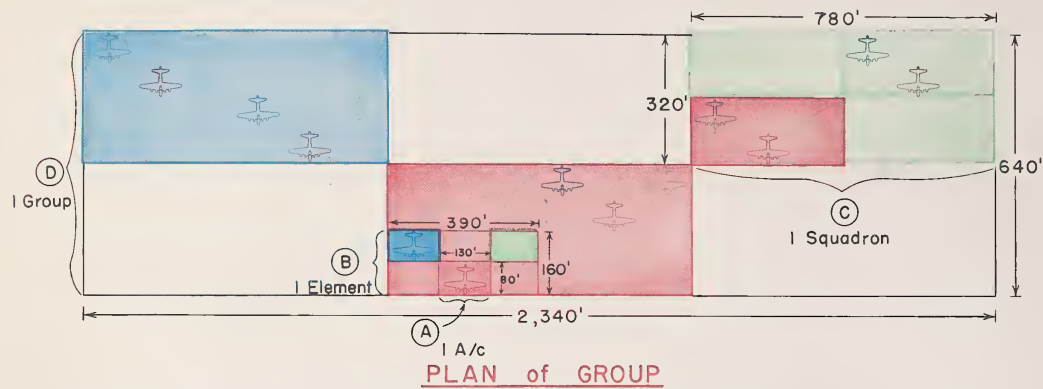
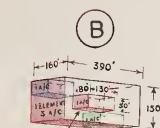


DIAGRAM 5

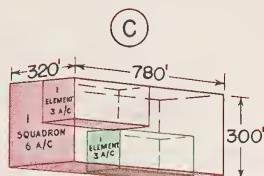
Individual Groups of 18 A/c each (February 1943)

WEDGE of GROUPS



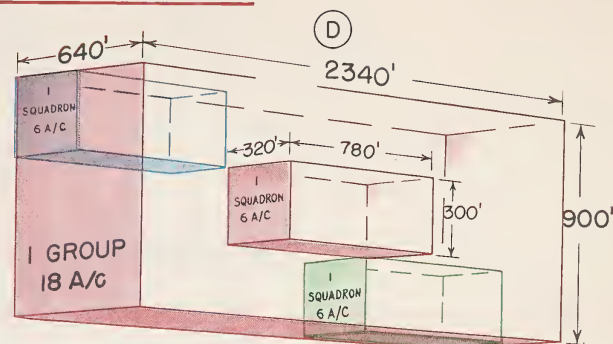
(A)
ELEMENT

3 A/c



(C)
SQUADRON

2 Elements of 3 A/c



(D)
18 A/c GROUP

3 Squadrons of 6 A/c

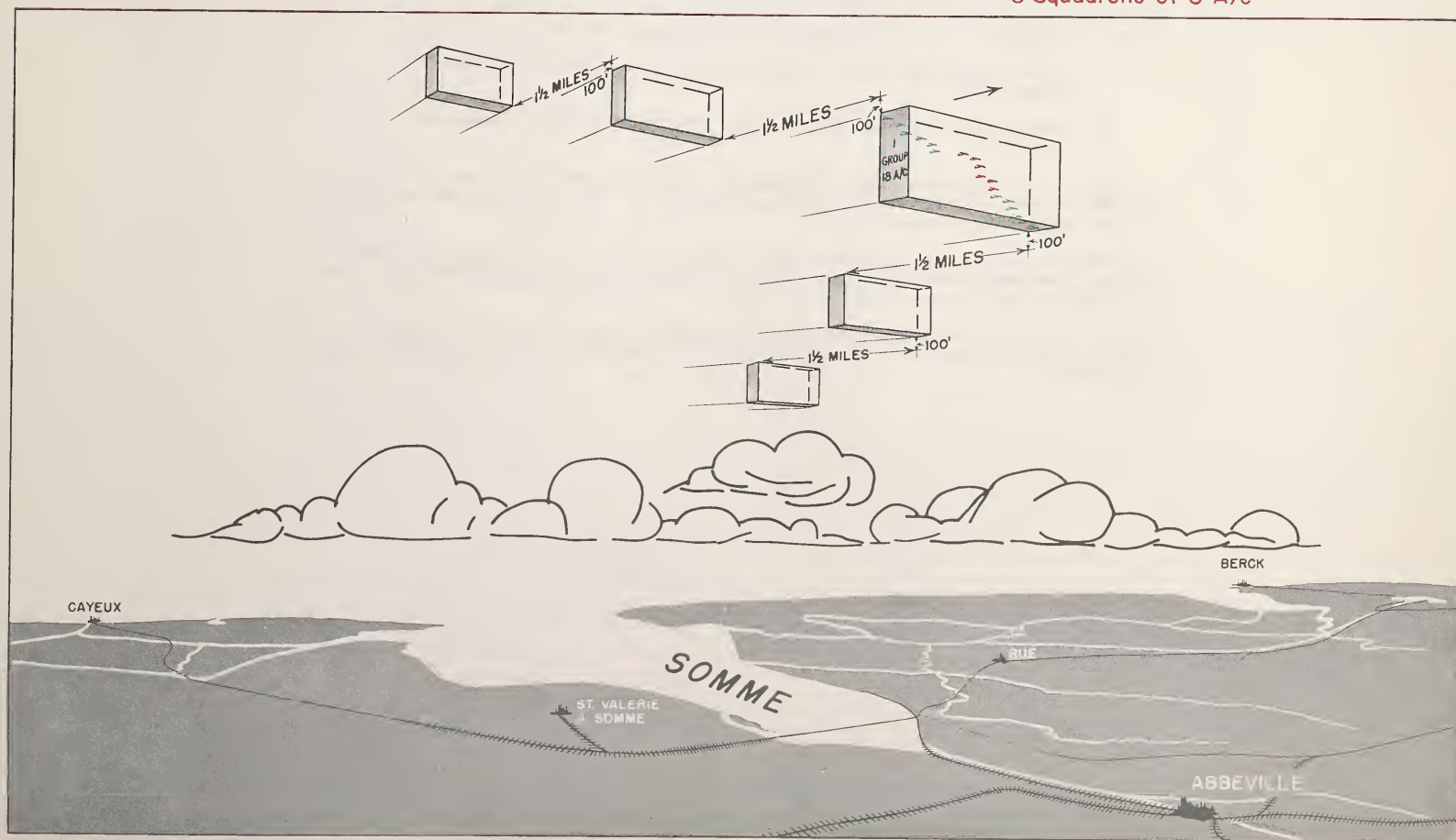


DIAGRAM 6 - THE EARLY 54 A/C COMBAT WING (MARCH, APRIL 1943)

"Stringing-out" became so bothersome that, in March 1943, a unit was developed consisting of the combat wing of three groups of 18 aircraft each (total varied from 54 to 60 aircraft). During the next few weeks variations were tried:

- (1) a lead group with one high wing-group and one low wing-group echeloned to the sides;
- (2) a lead group with high and low groups above and below and slightly in trail.

The latter arrangement resulted in greatly increased forward fire-power and mutual support, but was difficult to fly, particularly on turns. The high group had trouble keeping the lead group in view.

Even with the wing-men echeloned to the sides, this 54 aircraft formation proved unwieldy, and squadrons at the outside positions, high and low, where too few guns could be brought to bear, were exposed.

The doctrine of mutual support which prompted this larger formation was largely negated by the technical difficulties encountered. Consequently, it was replaced shortly thereafter.

DIAGRAM 6

COMBAT WING of 3 Groups of 3 Sqdns of 6 A/c each=54 A/c
Flown from March 1943 to April 1943 in 1st and 3rd Divisions

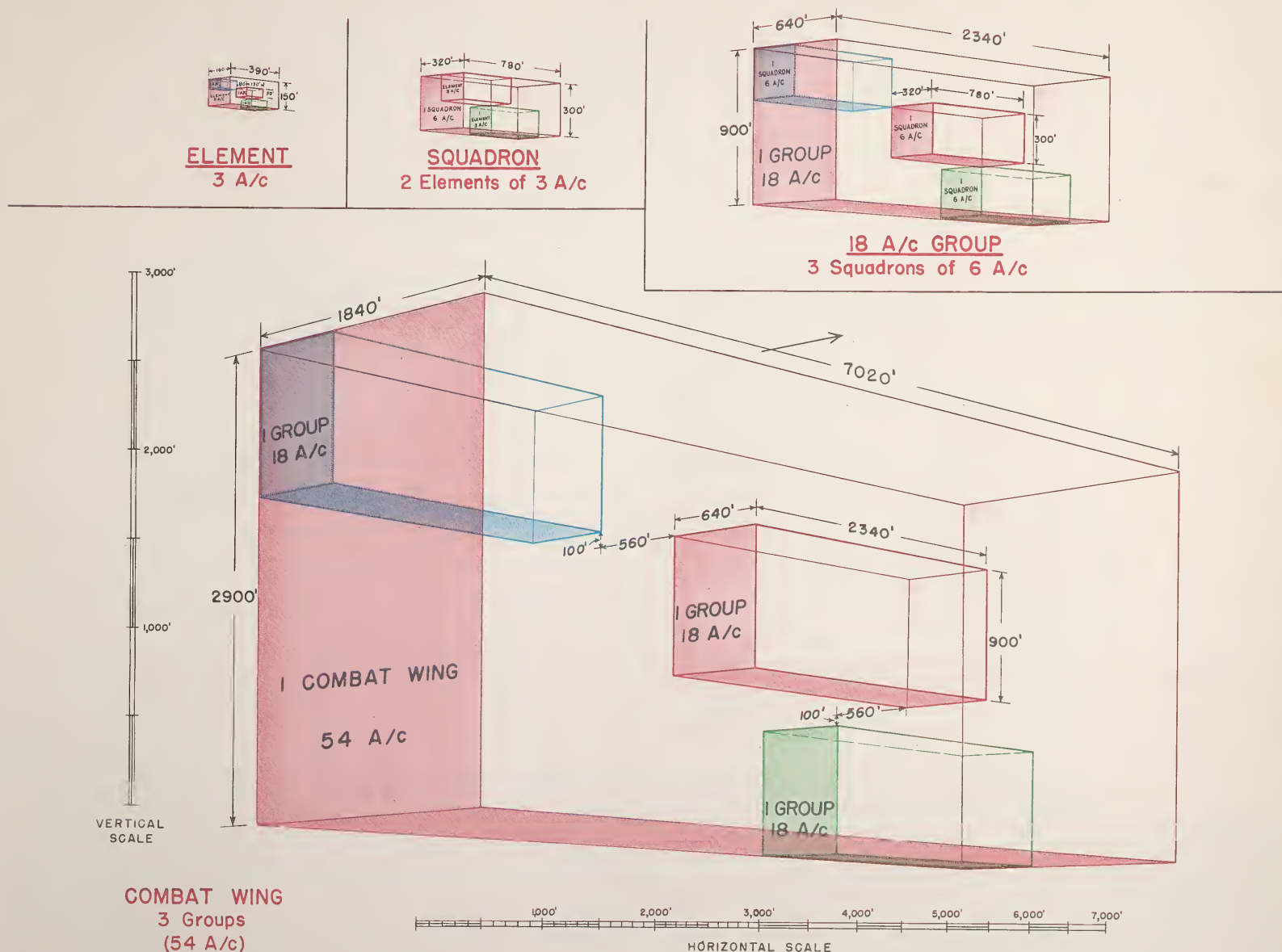


DIAGRAM 6

3 COMBAT WINGS of 54 A/c each (MARCH 1943)

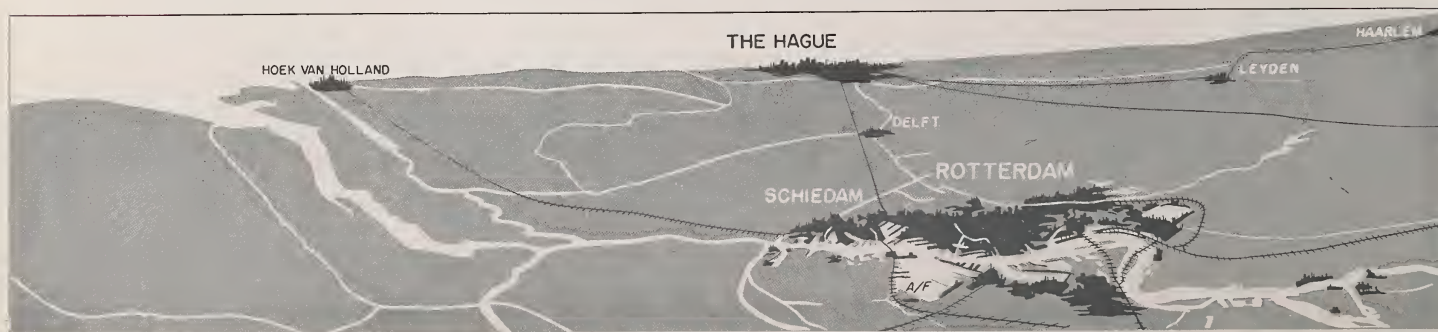
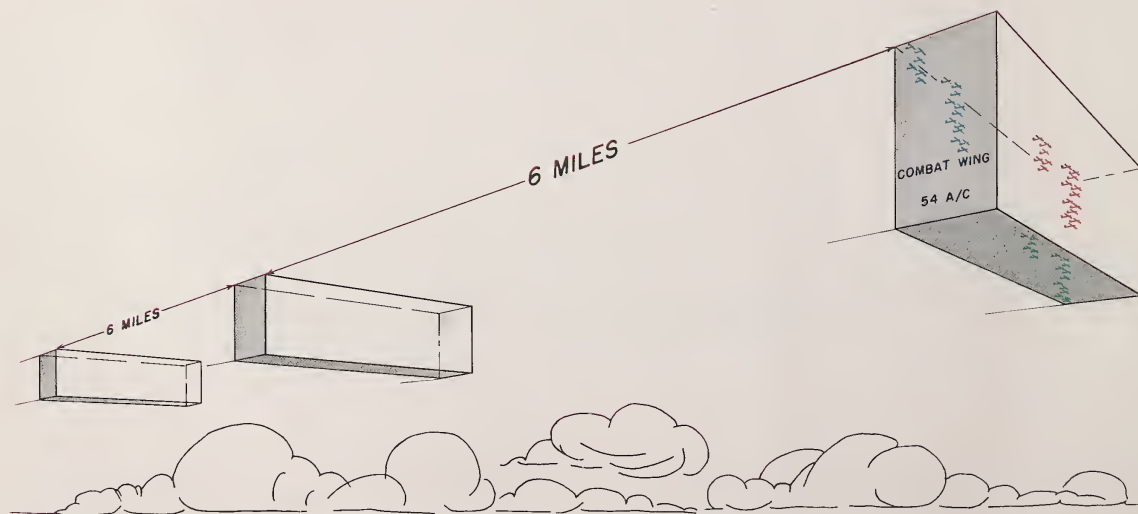


DIAGRAM 7 - MORE COMPACT COMBAT WING OF 54 A/C
(APRIL - DECEMBER 1943)

In June 1943, P-47's of the Eighth Fighter Command began escorting our bombers. As the force gained in both experience and equipment these fighters gradually increased their range from about 175 miles away from fighter bases in the United Kingdom to approximately 250 miles. In October 1943, P-38's joined them. But bomber penetrations deepened even further beyond escort range, increasing greatly the hazard from enemy fighter attack. Consequently, mutual fire-power support continued to be the most important factor in bomber defense, as the Luftwaffe waited for the fighter escort to return home before attacking the bombers.

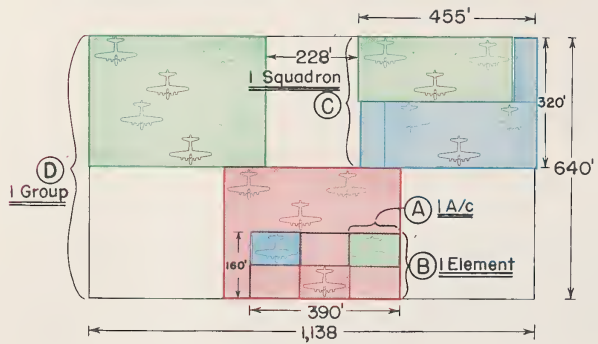
In this deadly struggle, the need for increased fire-power and minimum exposure heightened. Hence two important variations in the 54 aircraft combat wing formation were put into effect:

- (1) Aircraft in each element were stacked in one direction, while both the elements and squadrons were stacked in the opposite direction;
- (2) the previously exposed highest and lowest squadrons were "tucked in" behind by reversing the echelon of the elements in each wing squadron of each group.

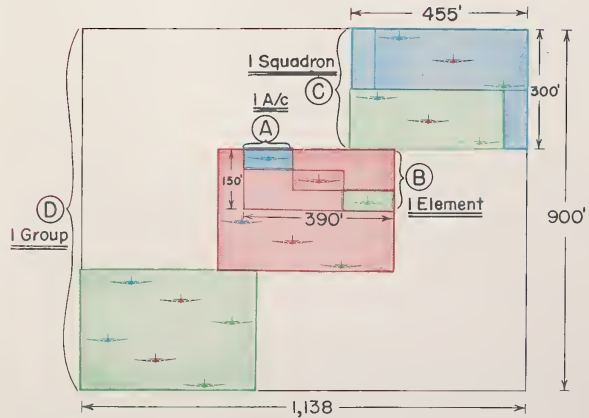
The "tucked-in" 54 aircraft formation afforded greater lateral compression, and considerably increased the number of guns uncovered, but it did little to solve the mounting problem of stragglers (responsible on some missions for over 50 percent of the aircraft lost). Twin-engine aircraft would lob rockets into a large bomber formation to disrupt it, after which the enemy, with coordinated single-engine attacks, would pick off the stragglers.

Deep and costly penetrations, such as those to Schweinfurt in August and October, finally caused discard of the inflexible 54 aircraft combat wing.

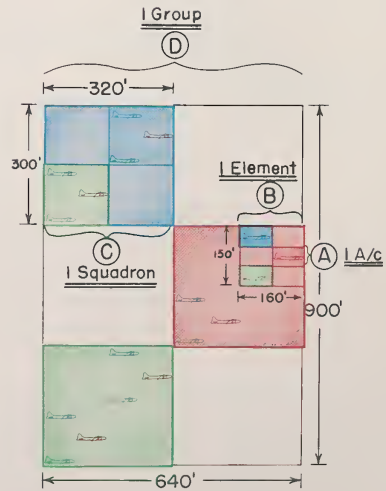
DIAGRAM 7



PLAN of GROUP



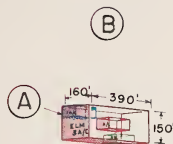
FRONT ELEVATION of GROUP



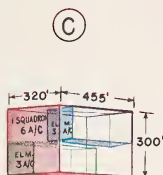
PROFILE of GROUP

DIAGRAM 7

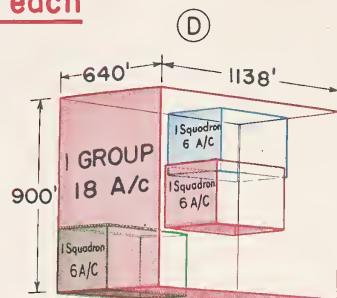
More Compact COMBAT WING of 54 A/c
3 Groups of 3 Squadrons of 6 A/c each
(APRIL to DECEMBER 1943)



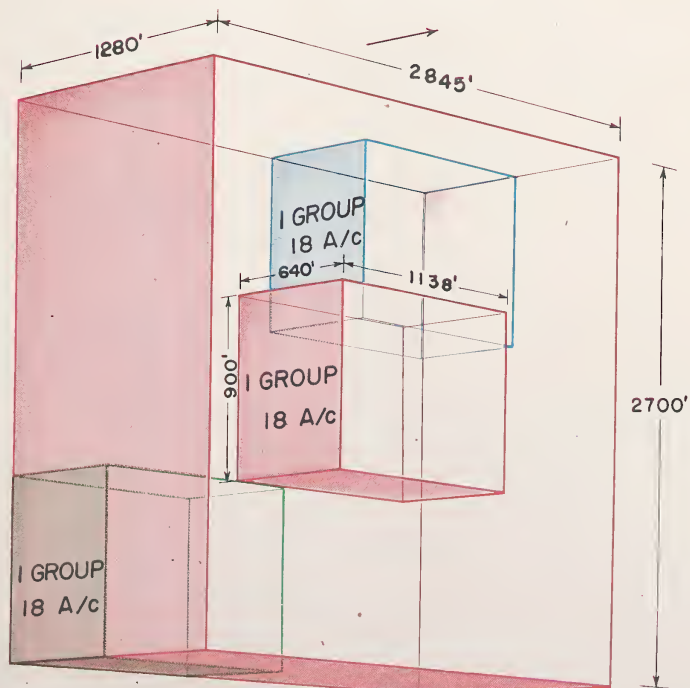
ELEMENT
 3 A/c



SQUADRON
 2 Elements of 3 A/c



18 A/c GROUP
 3 Squadrons of 6 A/c



54 A/c COMBAT WING
 3 Groups of 18 A/c

DIAGRAM 7

More Compact COMBAT WINGS of 54 A/c each (APRIL 1943)



DIAGRAM 8 - THE 36A/C GROUP (JANUARY 1944)

Between mid October 1943 and mid January 1944, the Eighth experimented with a revised 36 aircraft group, and after this period the 36 aircraft formation entirely replaced the unwieldy 54 aircraft combat wing.

Two factors, more than any others, influenced the adoption of the 36 aircraft group as Standard Operating Procedure:

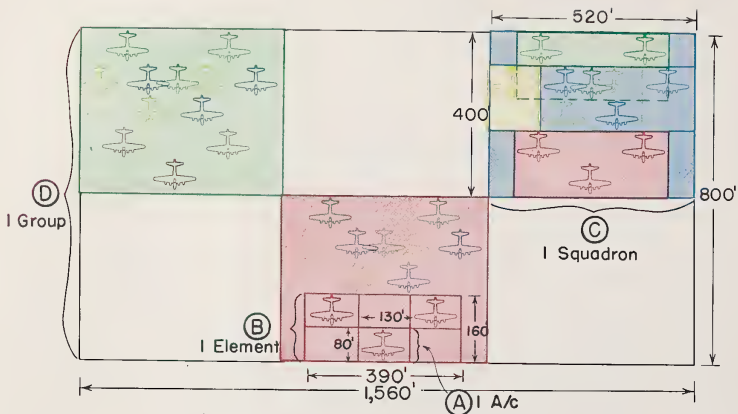
- (1) the introduction and extended use of overcast bombing;
- (2) the increasing range of fighter escort.

Seventy-five percent of the Eighth's attacks in January and February of 1944 involved German targets, and over half of these were bombed through the overcast. Because of the shortage of PFF (Pathfinder Force) equipment, it was necessary that the squadrons be compressed as tightly as possible. This was accomplished by fashioning a 12 aircraft squadron with four elements of 3 aircraft each. All aircraft in an element flew at the same elevation. The four elements were a lead, a high-wing, a low, and a low-low trailing. This uncovered more guns and increased cohesion of the individual unit, although the formation was still difficult to fly.

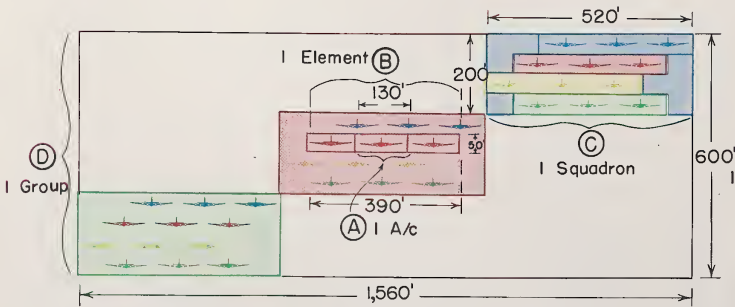
Escort problems affected the group formation as much as overcast bombing influenced the squadron. For all this time, the escort range and number of our fighters was increasing and more attention was being paid to flying bomber groups in a way best calculated to aid fighter escort. Savings of width and height were effected in the three squadrons which flew as a group consisting of lead, high-wing, and low-wing squadrons.

The effectiveness of this tighter formation and its fighter escort was established in the February debacle of the Luftwaffe, which was rendered temporarily impotent by a series of knockout blows during the Spring of 1944.

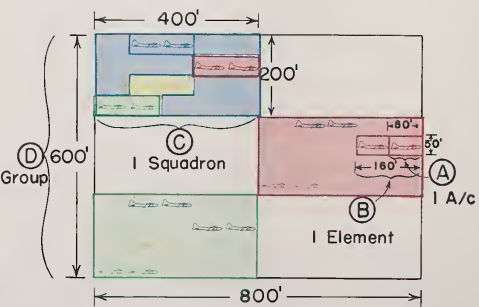
DIAGRAM 8



PLAN of GROUP



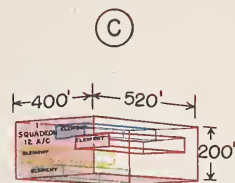
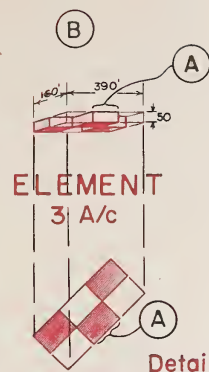
FRONT ELEVATION of GROUP



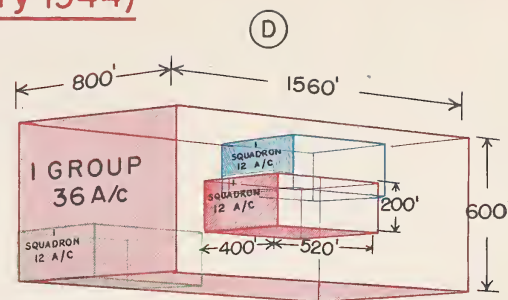
PROFILE of GROUP

DIAGRAM 8

The 36 A/c GROUP (January 1944)



SQUADRON
4 Elements of 3 A/c



36 A/c GROUP
3 Squadrons of 12 A/c

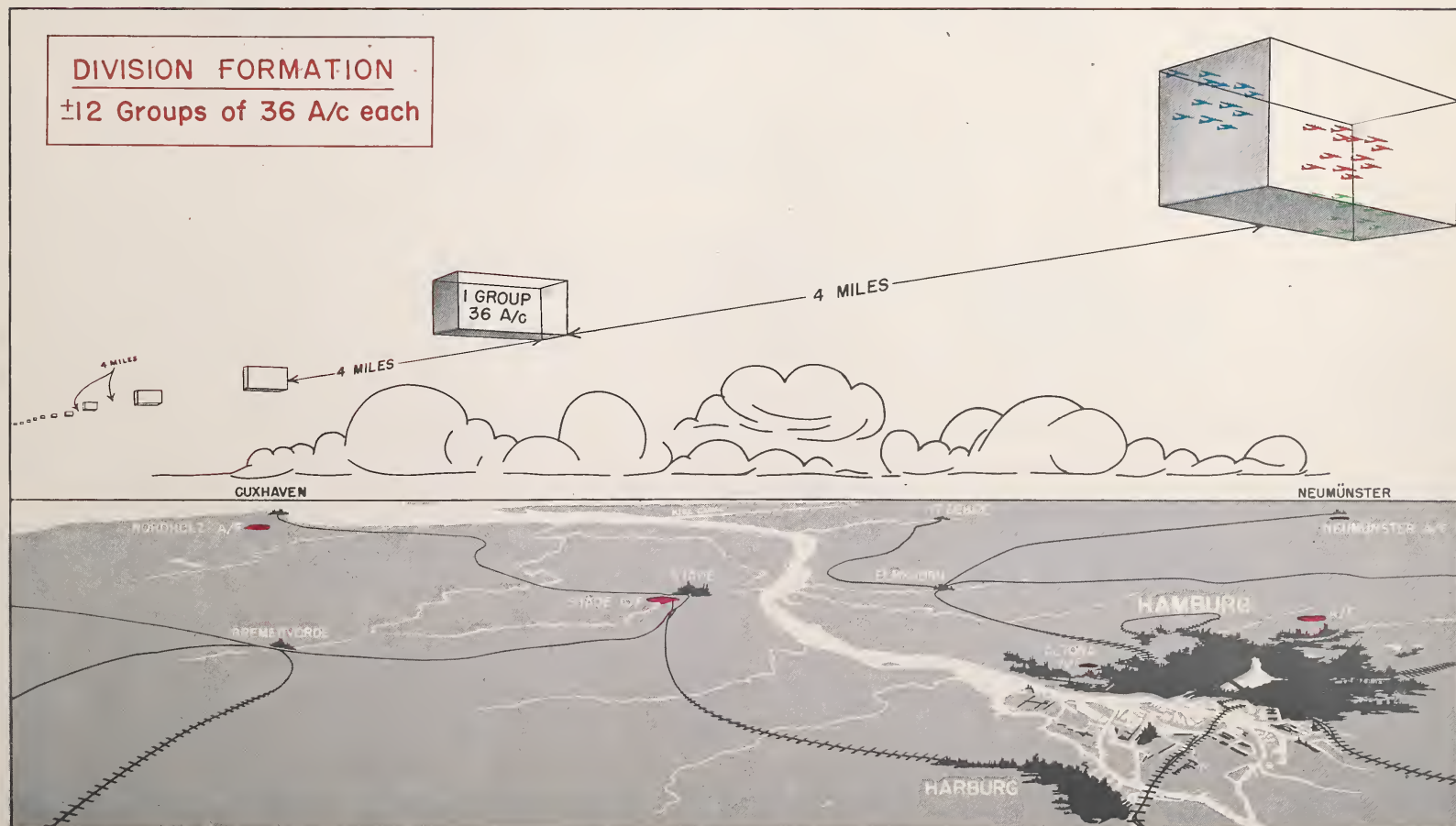


DIAGRAM 9 - THE 27 OR 36A/C GROUP - B-17 FORMATION
(FEBRUARY - APRIL 1945)

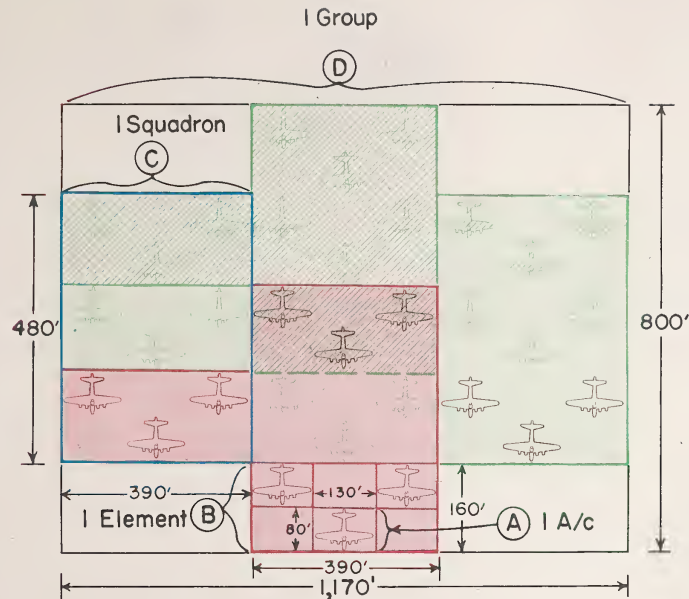
By 1945 the Luftwaffe was no longer a major threat. Lack of fuel and experienced pilots had reduced it to a mere shadow of its once-powerful self. Our bomber hours and sorties mounted; bomber combats decreased. Our expanded escort could now control the sky over all the target routes. Fighter cover had supplanted bomber fire-power as the first line of air defense.

Being able to rely less and less on their crippled Luftwaffe, the Nazis tightened and intensified their flak. What was needed then was a formation which could be easily escorted en route and still bomb targets as effectively but in less time and with less exposure to flak. Thus evolved the normal 27 aircraft group of three 9 aircraft squadrons, increasing to 36 aircraft when a fourth or low-low squadron was added.

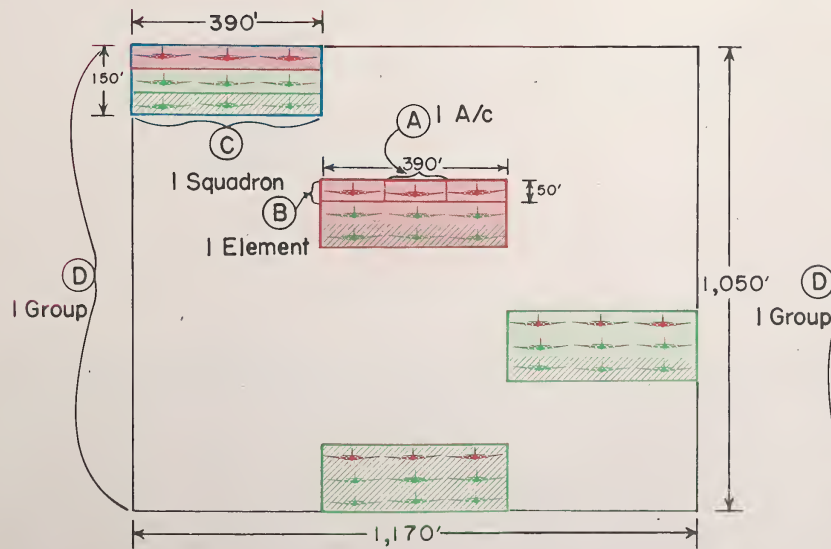
The new 9 aircraft squadron, compressed in air space, was superior to the 12 aircraft squadron in that it increased cohesion of the individual unit and afforded more flexibility. The smaller formation was easier to control and easier to fly. With less confusion it was now possible to obtain better results in the bomb pattern and reduce per-plane exposure to flak.

So satisfactory was the new formation that B-17s flew it until operations ended.

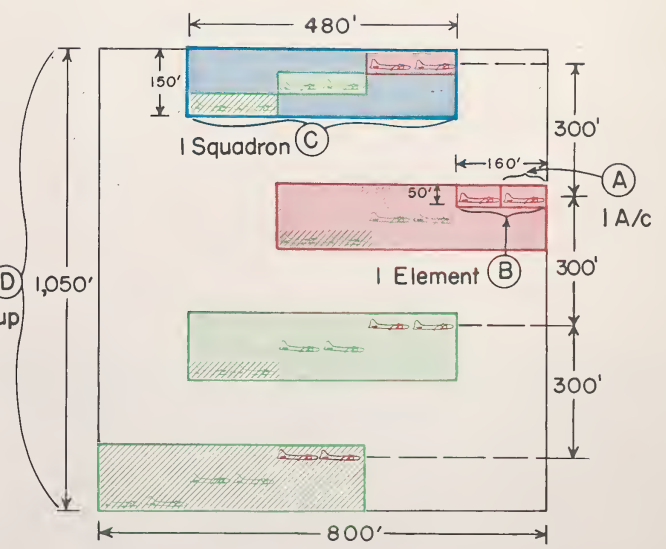
DIAGRAM 9



PLAN of GROUP



FRONT ELEVATION of GROUP



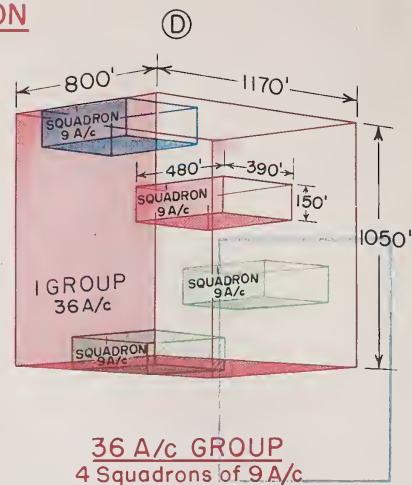
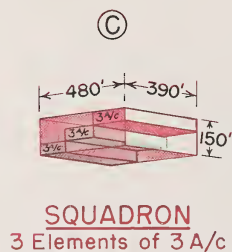
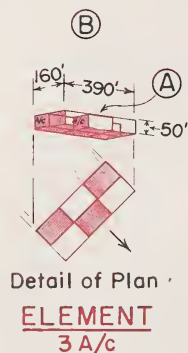
PROFILE of GROUP

DIAGRAM 9

THE 27 OR 36 A/c GROUP - B17 FORMATION

(February through April 1945)

4 SQUADRONS of 9 A/c each



DIVISION FORMATION ±12 Groups of 36 A/c each

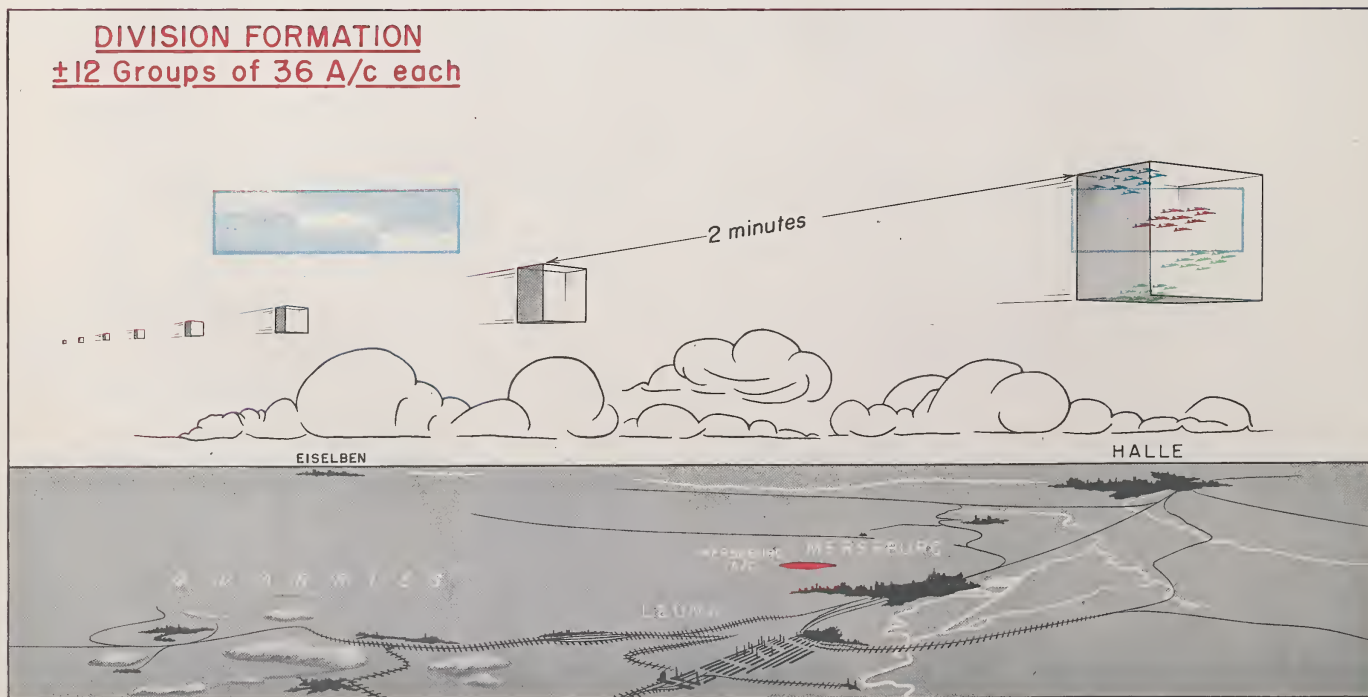


DIAGRAM 10 - THE 27A/C GROUP - B-24 FORMATION
(FEBRUARY - APRIL 1945)

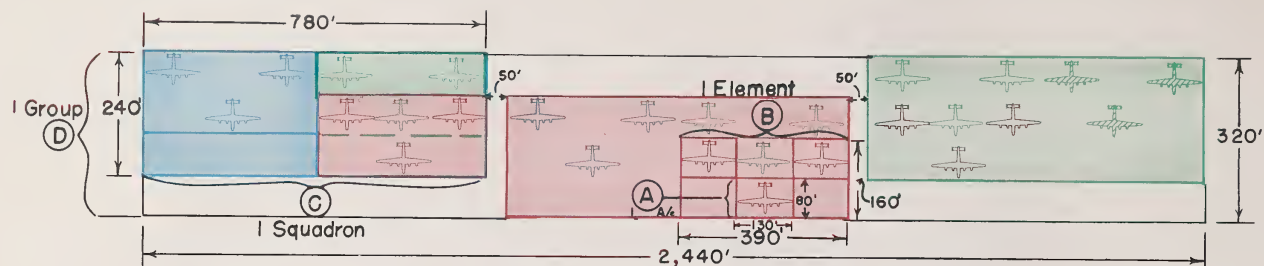
Because the B-24 is more difficult to fly in formation and has more restricted visibility, 2nd Air Division employed a slightly different 27 aircraft group formation from the B-17s during this period.

Basically, the formation depicted in Diagram 10 is similar to that in Diagram 9. For better bomb pattern, however, one element (either high or low wing) was flown to one side affording greater target coverage. The formation had the same advantages as those used by the B-17s and became Standard Operating Procedure.

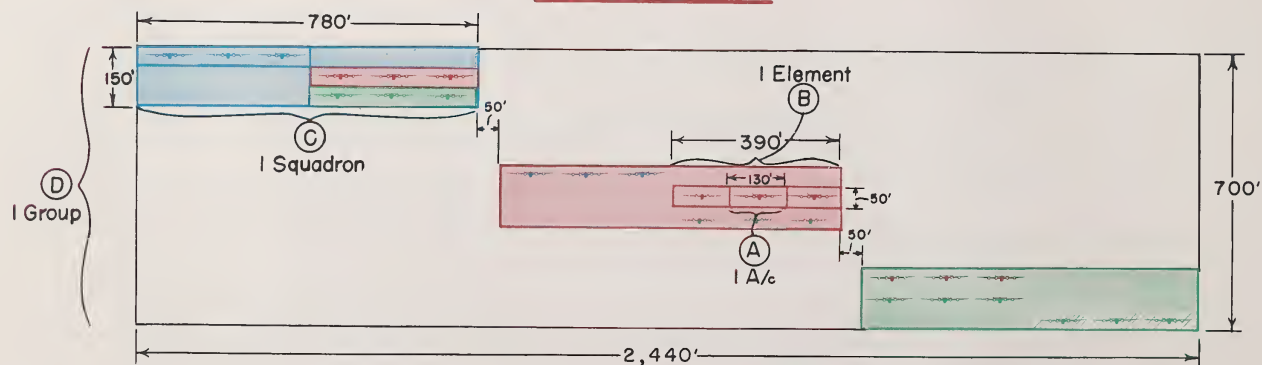
On the route in, number three or number two aircraft of the side element in a squadron would sometimes cross over and the other two aircraft would close in. This put two aircraft on one side of the squadron's main flight of six and one aircraft on the other side.

Bombing was accomplished by squadrons with less per-plane exposure to flak. Thus the enemy, short on Anti-Aircraft shells, was required to fire more per-plane in order to cause the same damage as he had to the old 54 aircraft combat wing and 36 aircraft group formations.

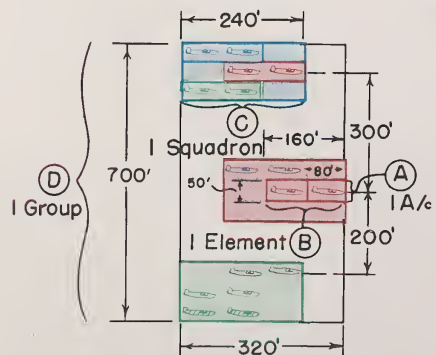
DIAGRAM 10



PLAN of GROUP



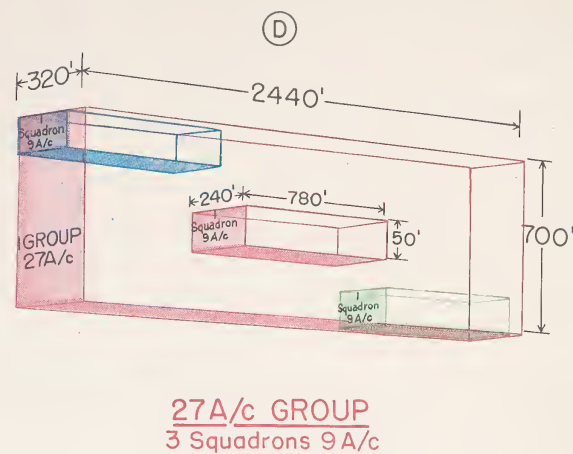
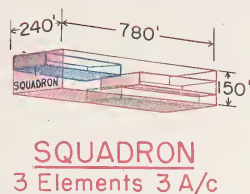
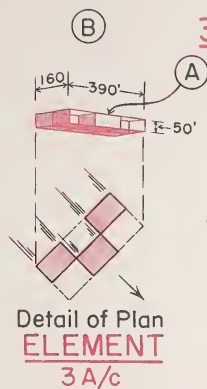
FRONT ELEVATION of GROUP



PROFILE of GROUP

DIAGRAM 10

THE 27A/c GROUP - B24 FORMATION (February through April, 1945) (Flown by 2ND Air Division) 3 SQUADRONS of 9 A/c each



DIVISION FORMATION ± 12 GROUPS of 27A/c each

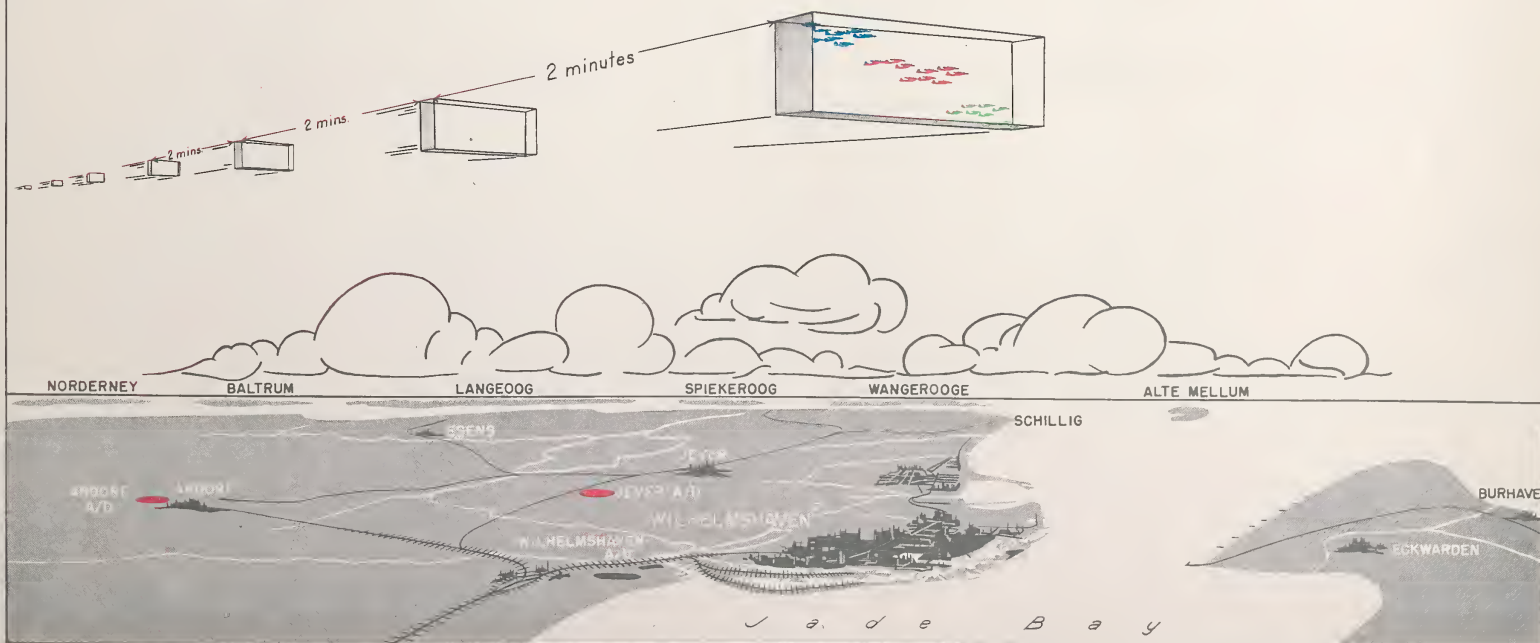


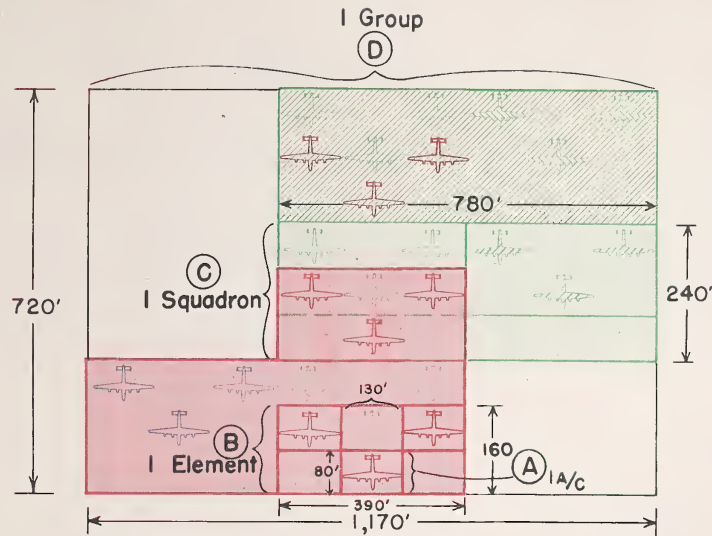
DIAGRAM 11 - THE 27A/C GROUP AS FLOWN BY 96TH COMBAT WING,
2ND AIR DIVISION - (FEBRUARY - APRIL 1945)

An improvement on the 2nd Air Division's formation (Diagram 10) was developed by the 96th Combat Wing. Instead of flying the three squadrons as a lead, a high right, and a low left, they were stacked in trail as a lead, a low, and a low-low.

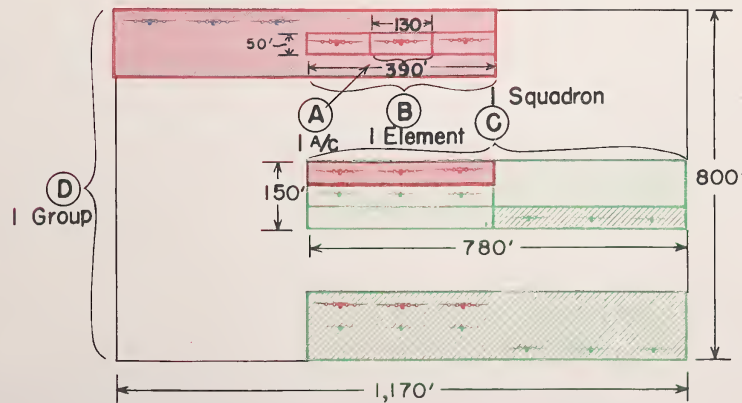
This enabled groups to fly at closer interval, especially on the bomb run, with the result that less aircraft were damaged by flak. Not only did it condense the size of the group box and improve the bomb pattern, but it also enabled all three groups to give each other superior fire support without losing the advantages of the formations shown in Diagrams 9 and 10.

Employment of this formation raised the standard of bombing accuracy and defensive fire power of this group to the highest level of performance.

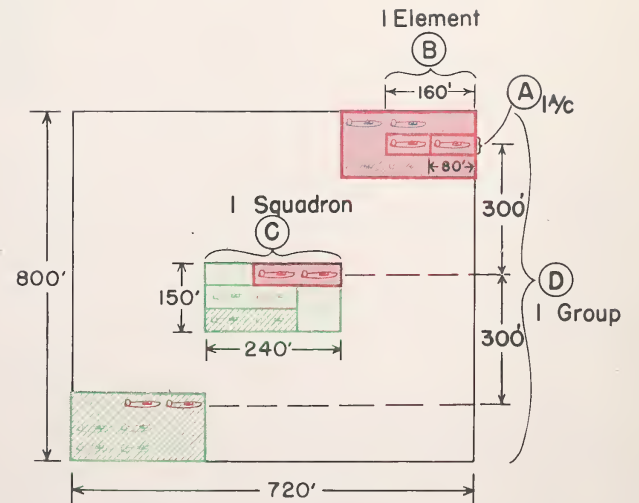
DIAGRAM II



PLAN of GROUP



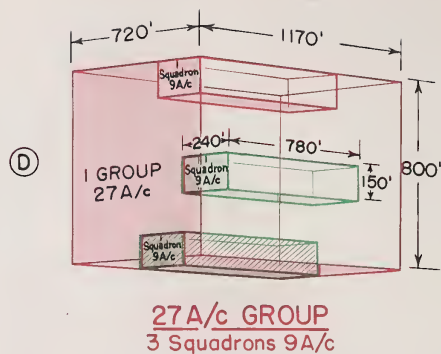
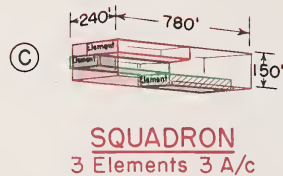
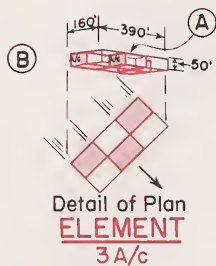
FRONT ELEVATION of GROUP



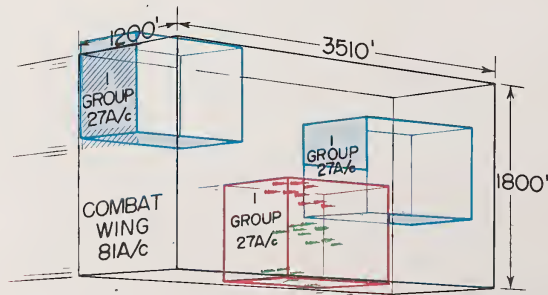
PROFILE of GROUP

DIAGRAM II

THE 27 A/c GROUP AS FLOWN BY THE 96TH COMBAT WING, 2ND AIR DIVISION (February through April 1945) 3 SQUADRONS of 9 A/c each



COMBAT WING FORMATION 3 GROUPS of 27 A/c each



OVERCAST ASSEMBLY PROCEDURE FOR EIGHTH AIR FORCE BOMB GROUPS

The diagram "Eighth Air Force Group Assembly Areas" shows the assembly areas used by each group when an overcast existed.

The unusual concentration of bomber bases in a limited area, and their proximity to one another demand inviolate adherence to this procedure. Otherwise fatal accidents would result. 3rd Air Division, for example, had to dispatch aircraft from 14 stations concentrated

in an area roughly 40 by 35 miles square. The other two Divisions faced similar problems.

Aircraft were required to take-off 30 to 45 seconds apart, sometimes in zero ceiling with less than 500 yards visibility. Pilots knew beforehand the exact headings, speed, distance separating each plane, and length of each leg in the pattern they were to fly. For self-protection, all climbed at the same rate

to the briefed spot where the assembly pattern took shape. And each group had its own buncher or splasher beacon for control points.

In this fashion they would sometimes climb through as much as 20,000 feet of overcast (80 to 90 minutes of instrument flying) in order to form on top, since assembly had to be made under conditions assuring 1,500 feet of clear air vertically.

BOMB RUN PROCEDURE AT INITIAL POINT

Eighth Air Force squadrons have followed three procedures in peeling off at the Initial Point prior to the bomb run.

Diagram "A" depicts the original procedure - in use from August 1942 through March 1944. The squadrons flew as a group, proceeding along the penetration route as lead, high, and low squadrons. Just prior to the Initial Point, all three took interval towards the outside of the turn. This allowed the lead squadron to turn directly over the Initial Point and make its bomb run to the target along the briefed course.

The second squadron, usually high, proceeded straight ahead until it uncovered the lead squadron. Then it turned toward the target to establish its bomb run.

Squadron three, usually low, followed the same procedure, turning after it uncovered the second squadron.

Thus the three squadrons unhindered by one another could fly along separate paths toward the same target. In this procedure only the

first squadron made its bomb run on the briefed course. The other two did not fly the briefed path and encountered the problem of identifying the target from a different heading. Experience revealed that the first squadron did the most accurate bombing. Therefore a change in procedure was instituted in order to improve the bombing of the entire group.

Diagram "B" - In March 1944 a new "fanning out" procedure was adopted. This enabled all three squadrons in a group to turn over the briefed Initial Point and fly along the briefed bomb run to the target.

In this procedure the three squadrons - lead, high, and low - followed the penetration route until they reached a spot not more than five minutes before the Initial Point. Then the lead squadron proceeded straight ahead while the other two took interval to the outside of the turn as follows. The second (high) squadron, echeloning away from the direction of turn, took interval of approximately two miles to the side of the lead squadron. Number two then flew parallel to the original course, maintaining the lateral interval.

Likewise, the third (low) squadron spaced itself an equal distance to the outside of the second, maintaining the lateral interval along a parallel course, but echeloned out and back.

This enabled all three squadrons to turn and pass directly over the briefed Initial Point and move in trail toward the target as briefed with an interval of approximately two miles between squadrons.

As a result all three maintained their altitude differences, had enough interval to avoid interference and flew the same course without having to identify the target individually on unbriefed headings.

Diagram "C" - in January 1945 came another change. Flak losses dictated that the column must be shortened for the bomb run so that each group's "passing-over" time would also be cut. Interval between squadrons was subsequently reduced from 40 to 20 seconds with the result that an entire group could pass over the target in approximately one minute. This procedure remained in effect until the end of the war.

EIGHTH AIR FORCE GROUP ASSEMBLY AREAS (USED WHEN OVERCAST EXISTS)

LINCOLN
⊙

NOTTINGHAM
⊙

DERBY
⊙

LEICESTER
⊙

COVENTRY
⊙

HUNTINGDON
⊙

NORTHAMPTON
⊙

BEDFORD
⊙

OXFORD
⊙

CAMBRIDGE
⊙

NORWICH
⊙

IPSWICH
⊙

COLCHESTER
⊙

CHELMSFORD
⊙

LONDON
⊙

NORTH SEA

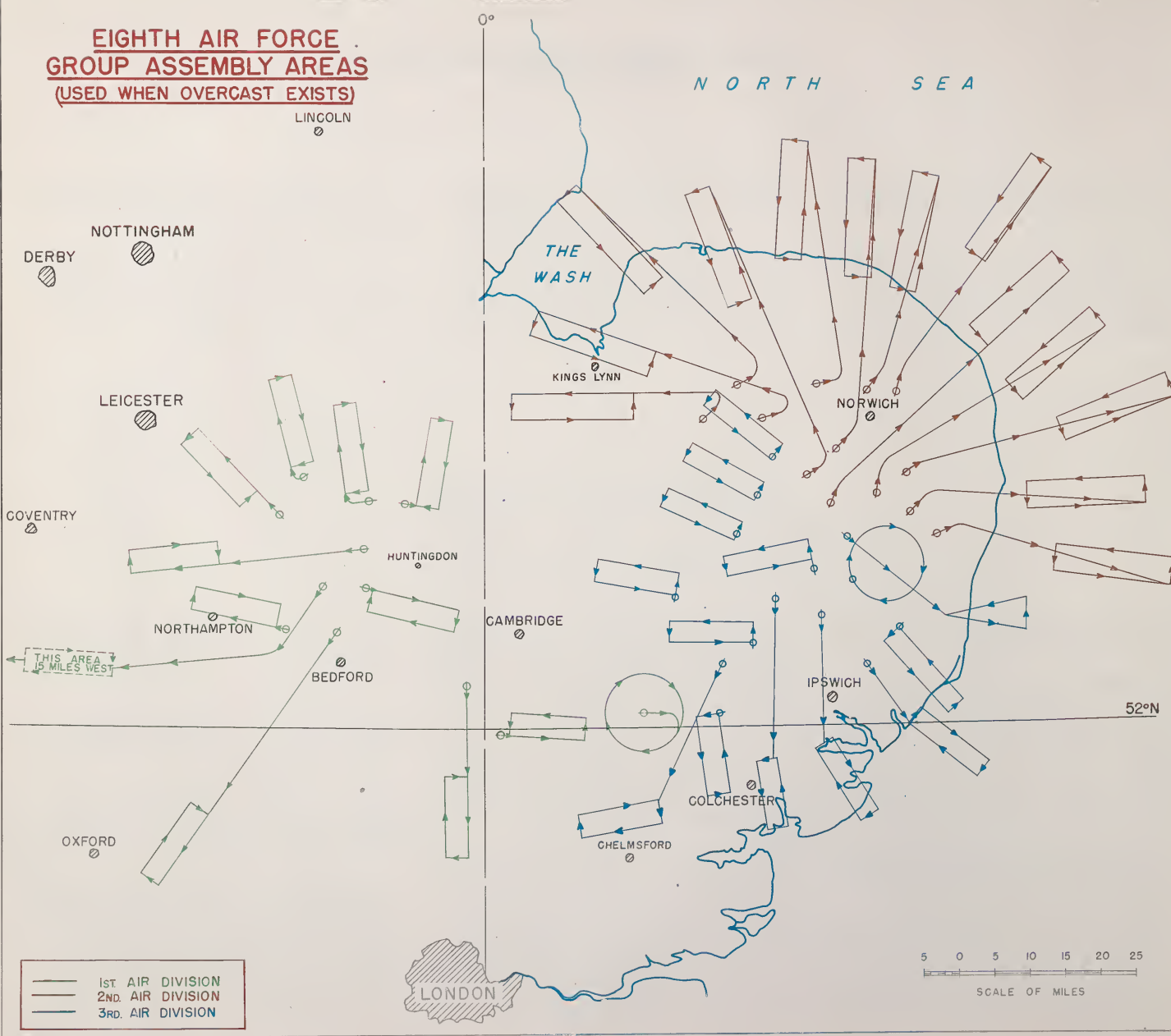
THE WASH

KINGS LYNN
⊙

52°N

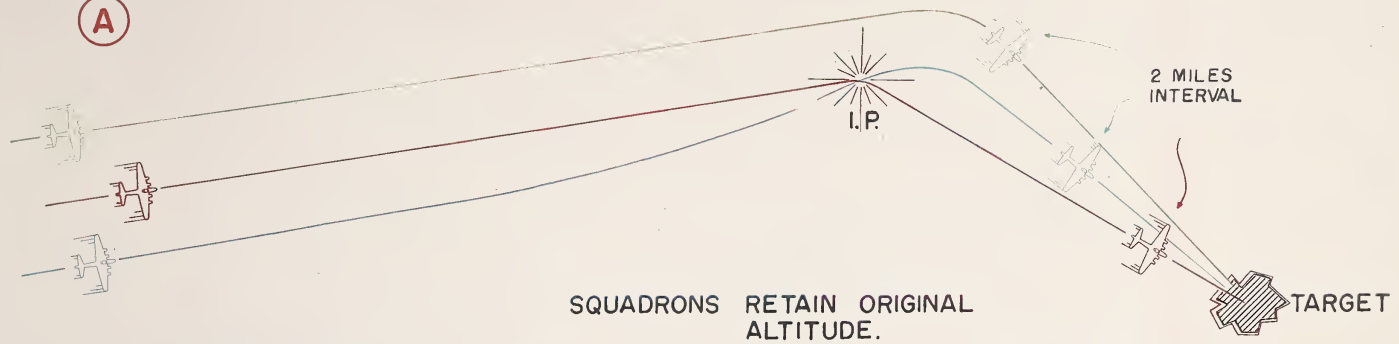
— 1ST AIR DIVISION
— 2ND AIR DIVISION
— 3RD AIR DIVISION

5 0 5 10 15 20 25
SCALE OF MILES

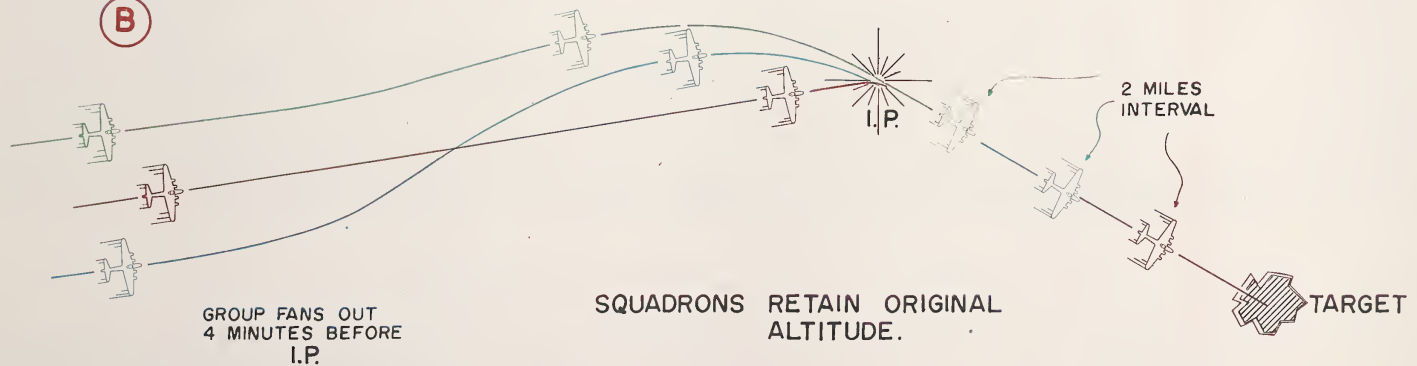


PROCEDURE at I.P. for BOMB RUN.

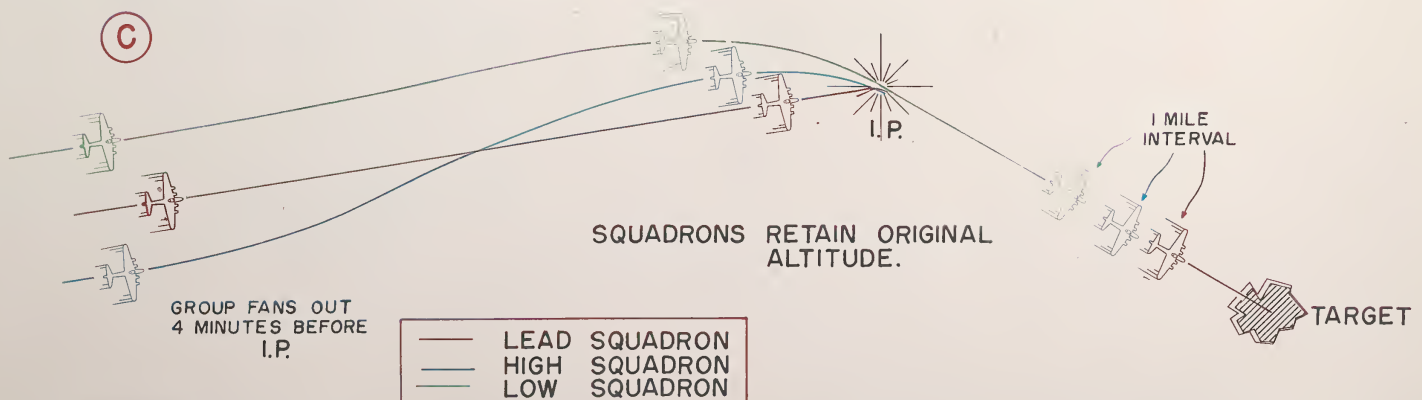
(A)



(B)



(C)



A TYPICAL MISSION

For the Eighth Air Force bombing of Berlin on 18 March 1945, a huge force of bombers took off; climbed through 3,000 feet of overcast; assembled by Group, Wing and Division; flew a briefed penetration route; maneuvered at the Initial Point for the bomb run; bombed; reformed at the Rally Point; flew a briefed withdrawal route; disassembled by Division, Wing and Group; then the entire force landed.

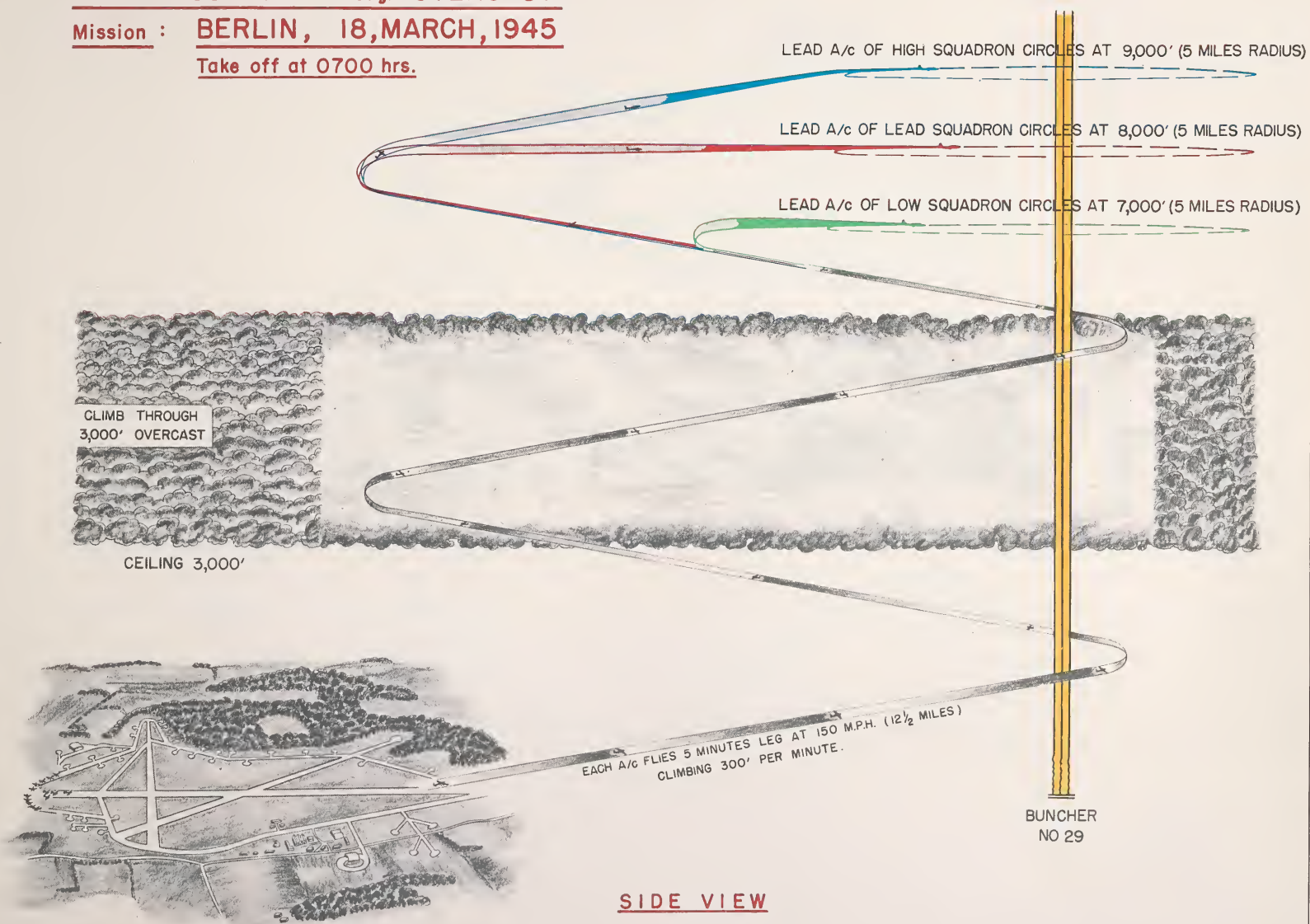
The following eight diagrams show how this was done. A rigid time schedule governed each phase of the mission from the moment the first plane took-off until the entire force landed.

No 1

GROUP ASSEMBLY through OVERCAST

Mission : BERLIN, 18, MARCH, 1945

Take off at 0700 hrs.



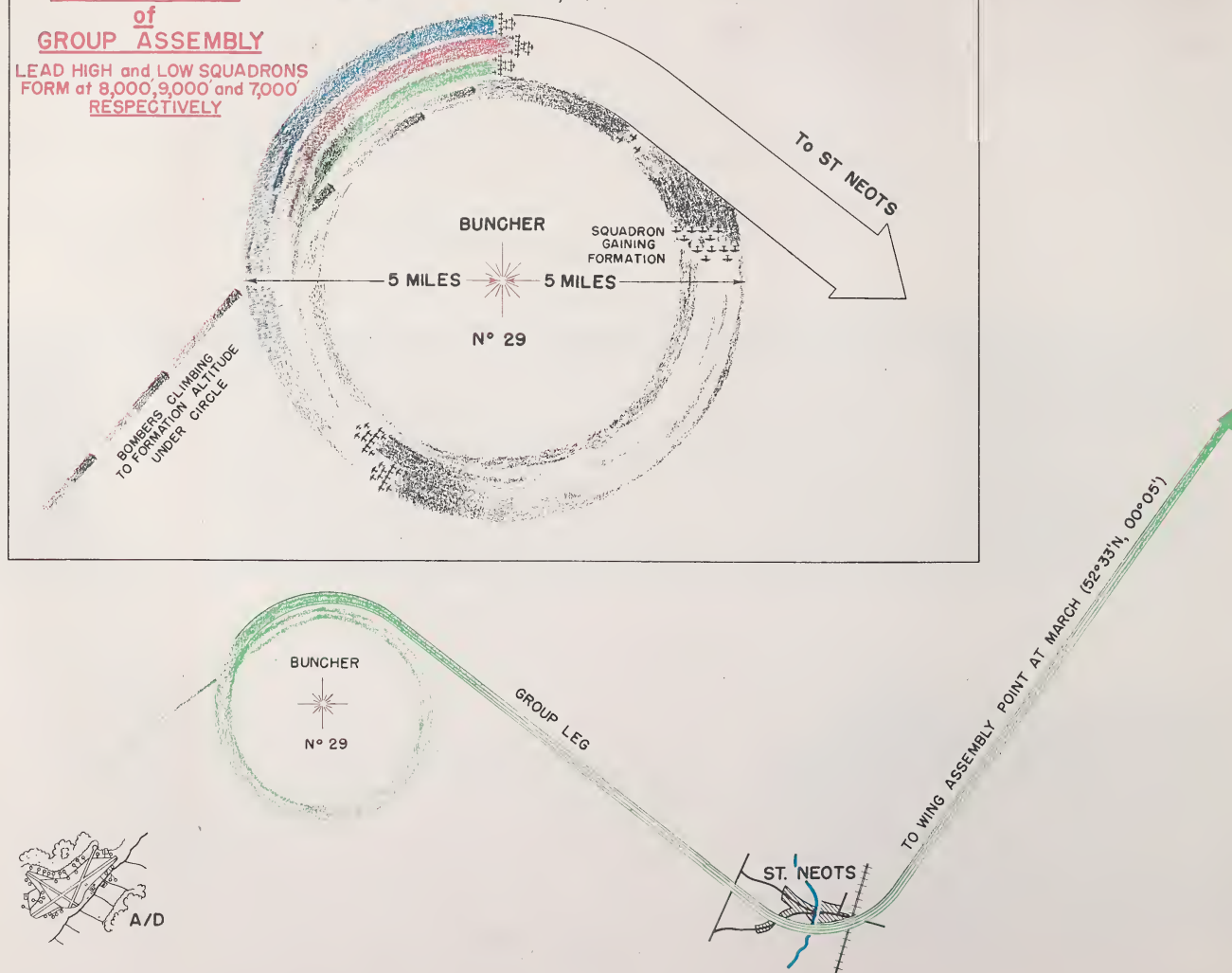
N° 2

DETAIL PLAN

of GROUP ASSEMBLY

LEAD HIGH and LOW SQUADRONS
FORM at 8,000', 9,000' and 7,000'
RESPECTIVELY

36 A/C GROUP FORMED AT 0816HRS.
PROCEEDING ON FIRST LEG AT 8,000 FT.



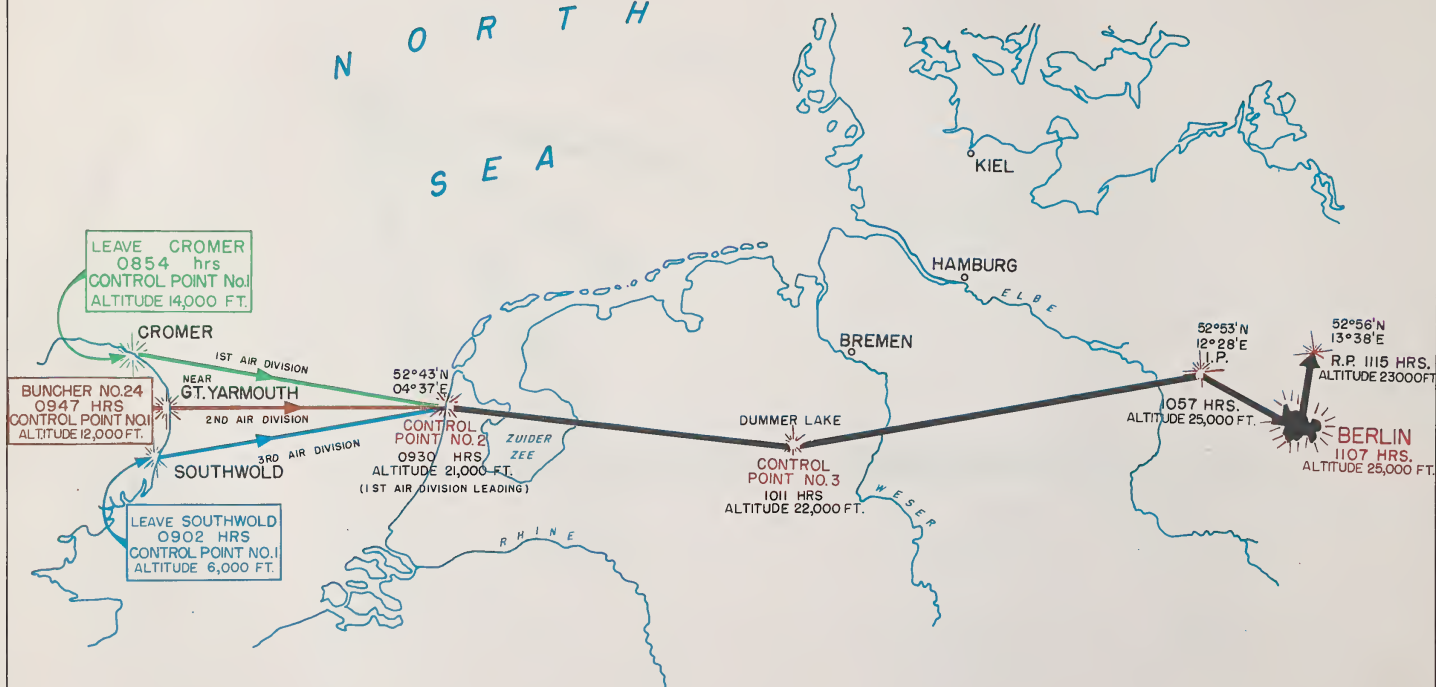
Nº 3



WING and DIVISION
ASSEMBLY

No. 4

N O R T H
S E A

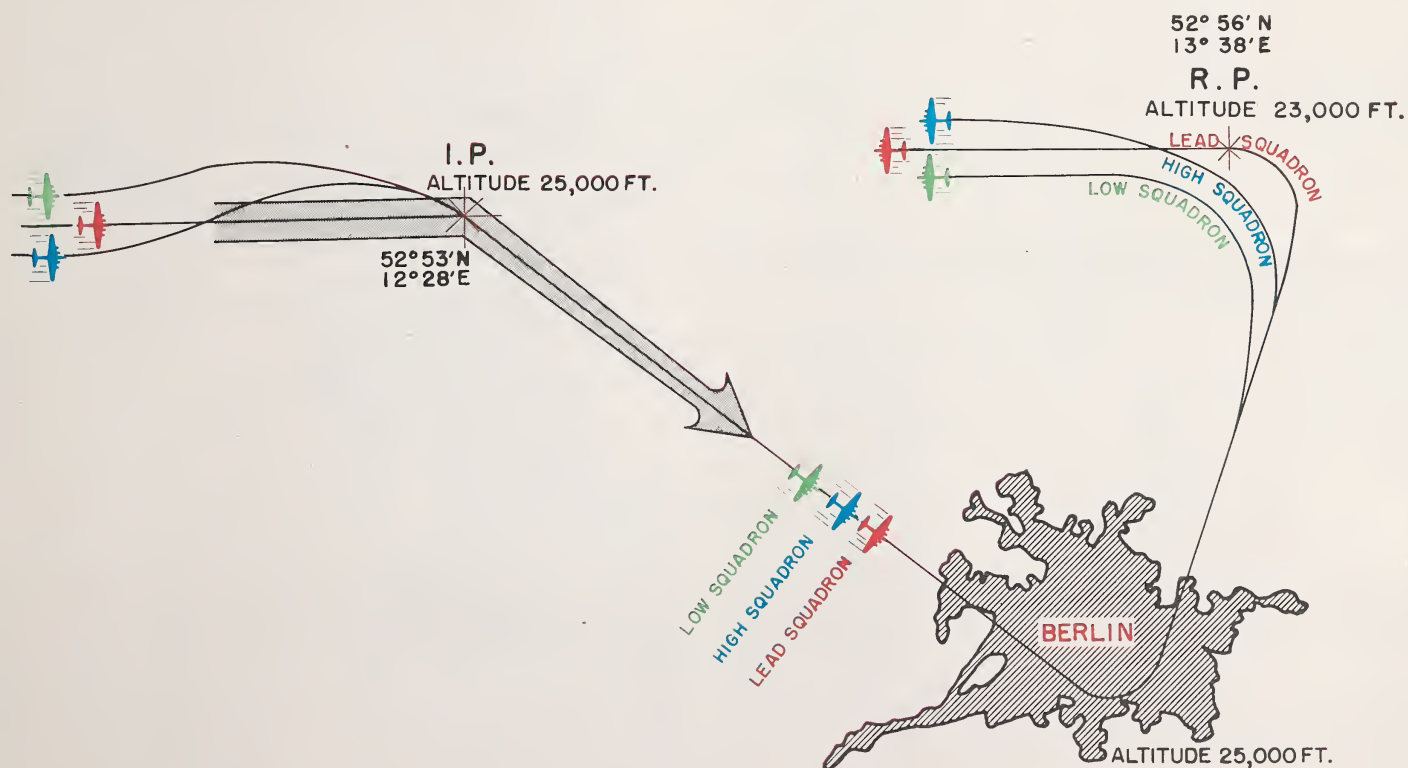


ROUTE to TARGET
and
RALLY POINT

GROUP MANEUVER

AT
INITIAL POINT

AND AT
RALLY POINT



P L A N

No. 6



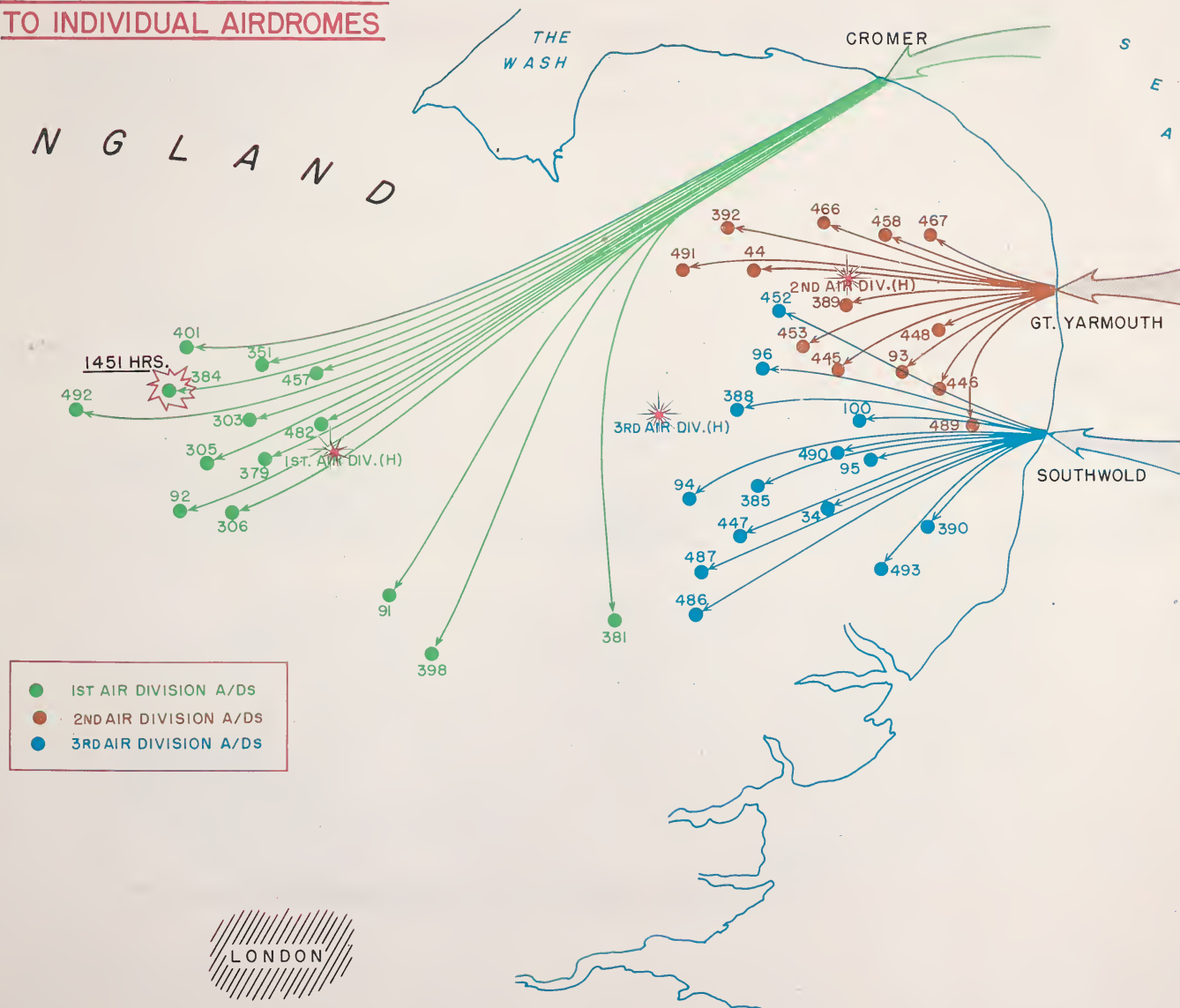
ROUTE OUT
from
RALLY POINT

AIR FORCE DISPERSION TO INDIVIDUAL AIRDROMES

N O R T H

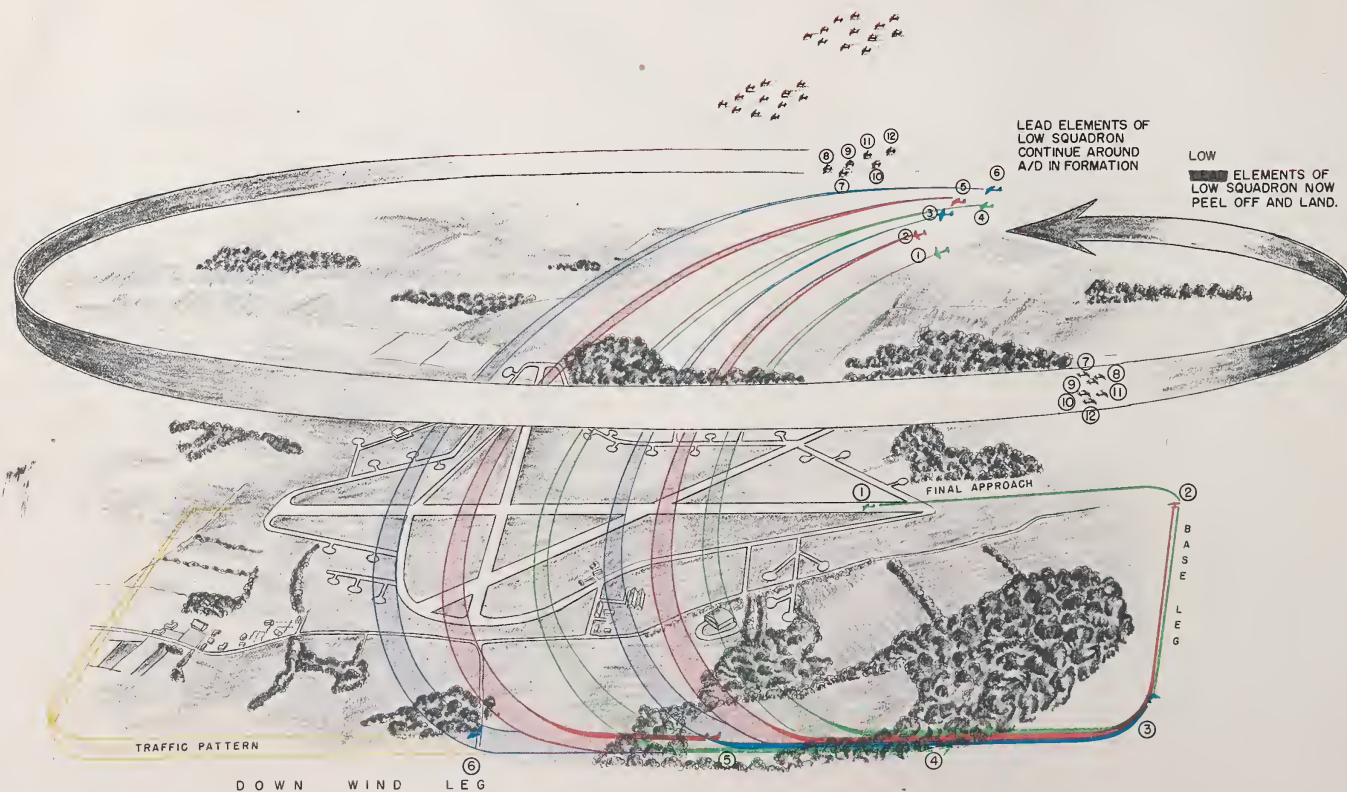
Nº 7

E N G L A N D



GROUP LANDING PROCEDURE at BASE

LEAD AND HIGH SQUADRONS
MAKE A WIDER CIRCUIT OF A/D.
LEAD SQUADRON THEN LANDS
IN SAME MANNER AS THE LOW
SQUADRON. HIGH SQUADRON
CONTINUES AROUND ONCE MORE
AND THEN LANDS.



CHAPTER II

THE DEVELOPMENT OF
BASIC FIGHTER FORMATIONS
AND
PROCEDURES

TO THE LIMIT OF THEIR ENDURANCE

Escort operations of the Eighth Fighter Command were divided into two main phases. From 4 May 1943, when P-47's escorted Fortresses for the first time, through January 1944, fighters were tied closely to the bombers. They were not permitted to desert formations to pursue enemy aircraft. After January 1944 the doctrine of "ultimate pursuit of the enemy" was adopted and our fighters were allowed to follow the enemy until they destroyed him in the air or on the ground.

Three P-47 groups actually began operations during April 1943 by flying patrols and sweeps such as Royal Air Force Spitfires were carrying out. During this period, our fighters tried the Royal Air Force practice of keeping a close and orderly formation with 50 to 75 feet between aircraft. On the early escort missions beginning in May, they flew an "umbrella" over the Fortresses similar to that used by the Royal Air Force in providing cover for Wellingtons - which had tail and front turrets but lacked overhead defense.

In applying the umbrella principle to B-17 escort, however, the P-47's found that German Air Force fighters would attack at the level of the bombers from the sides and front, while defending aircraft remained idly above. The umbrella soon was abandoned, and P-47's on escort spread out more and flew closer down to the bomber level.

The Royal Air Force idea of a two-ship element, with the wing man slightly above and to the rear, was retained. United States training in "Y" elements of three aircraft flying level was abandoned. Eventually the P-47's combined two two-ship elements into a four-ship flight which called for an almost line-abreast formation. Except for subsequent wider separation of aircraft, this four-ship flight remained basic.

During the initial period, escort was possible only for 20 to 30 minutes, since auxiliary tanks were not yet in use. Groups flying out to rendezvous with bombers, whenever possible avoided enemy fighters, for their assigned mission was to reach and protect the bombers.

Escort tactics all this time were being influenced by three main factors:

- (1) the need of bombers for increasing protection,
- (2) enemy strength and disposition,
- (3) growth of fighter range.

The presence of P-47's after May 1943 forced the German Air Force fighters to alter their own tactics. Formerly the enemy had attacked our bombers at the French Coast. They soon learned to withhold these attacks until the P-47's exceeded their limit of endurance. But on 28 July 1943, a few P-47's achieved tactical surprise by using 75-gallon external tanks for the first time. Immediately the number of enemy aircraft shot down increased sharply. By October, four new Thunderbolt groups became operational. About this time, 108-gallon belly tanks came into use. The P-47 so equipped, extended its range, finally reaching 375 miles from base with this fuel capacity.

"Y" Service also made its operational appearance during this period, enabling groups, out on sweeps to be vectored to enemy rendezvous points. This resulted in some interference with the large German Air Force concentrations preparing to attack our bombers. Another method of control by British "Type 16" equipment was effective within limited range for vectoring our fighters on enemy aircraft.

The first group of P-38's became operational in October to provide escort and target support beyond the range of the P-47's. For a time small numbers and unforeseen mechanical difficulties limited their effectiveness, but in December another P-38 group and a group of P-51B's were added with excellent results.

Range increases affected escort formations. Back in June 1943, escort began to open out in order to cover more sky space. There was no drastic spreading; only 100 yards or so between aircraft. Then as penetrations deepened, the fighter formations opened still wider, with aircraft approximately 250 yards apart. Distances between aircraft, altitude flown, and tactics employed would vary with each fighter

group. Air Commanders were encouraged to experiment with new tactics, and did. However, the four-ship Battle Formation remained basic (Diagram 1).

On 4 January 1944, P-38's and P-51's increased their escort range to Kiel and Munster the next day P-47's accompanied the bombers as far south as Bordeaux. Longer fighter range now made possible a vital change in battle doctrine. Group Commanders were ordered to pursue the Hun until he was destroyed. "Put the fear of God into them" was how one fighter controller summed it up. Commanders could exercise judgement in leaving the bombers to search for the enemy under the doctrine that such offensive tactics accelerated destruction of the German Air Force. When the Hun did not come up to give battle, the fighters went down after him, singling out airfields to strafe and bomb when not providing escort.

The battle formation of 4 aircraft flying approximately 250 yards apart continued. Only now, groups spread out their basic elements to cover more ground, ranging out 7 or 8 miles to the sides of the heavies. Then in the latter part of January 1944, one P-47 group experimented with a sweep formation, spreading out as scouts over a 45-mile front well in advance of the bomber stream. Although this "Zemke fan" proved too vulnerable to enemy attacks, it did blaze the way for modified sweep tactics used effectively later on.

Increased range made this possible. By March 1944, P-38's had a potential radius of 585 miles; P-51B's, 650 miles with two 75 gallon wing tanks. Then the P-51's began to use two 108 gallon tanks, increasing their potential radius to 850 miles.

The 29 May 1944 marked an historic occasion for fighter escort. On that day P-51's furnished target support at Posen, Poland (over 700 miles from base) and returned with the bombers. From then on fighters escorted the bombers wherever they went. In June, P-51's flew escort all the way to Poltava in the Ukraine, (1700

(CONTINUED ON PAGE 52)

FIGHTER ESCORT

BATTLE FORMATION

PLAN VIEW

DIAGRAM 1

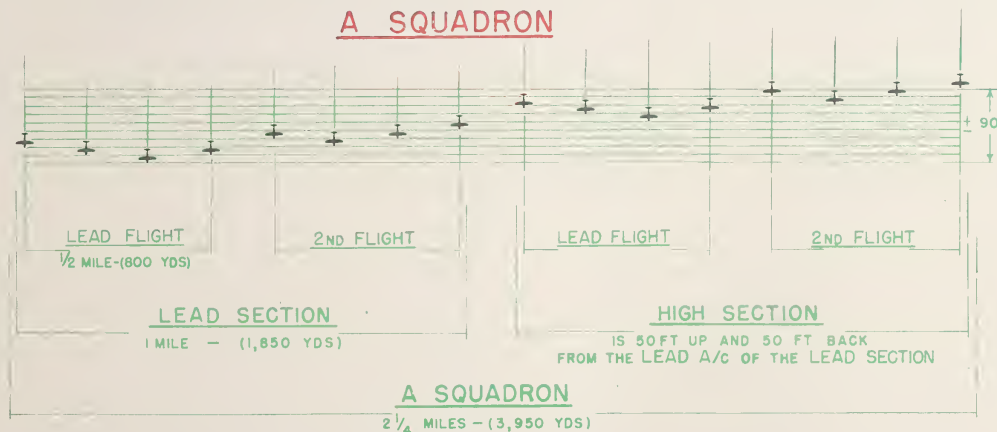
A FLIGHT



THE FLIGHT : 4 A/C.

TWO ELEMENTS OF 2 A/C EACH. WING MAN OF EACH ELEMENT FLIES WITH NOSE OPPOSITE CANOPY OF HIS LEADER. LEADER OF THE SECOND ELEMENT FLIES WITH NOSE OPPOSITE CANOPY OF LEADER OF LEAD ELEMENT. ALL A/C FLY AT THE SAME ALTITUDE, AND APPROXIMATELY 250 YDS. APART.

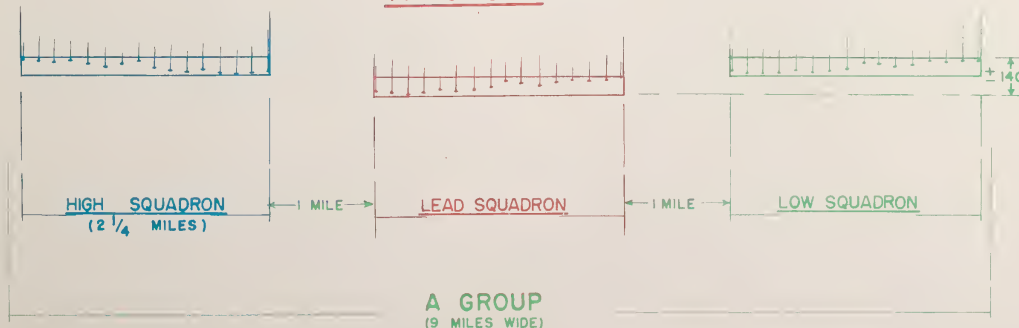
A SQUADRON



A SQUADRON : 16 A/C.

TWO SECTIONS EACH HAVING 2 FLIGHTS. THE HIGH SECTION FLIES APPROXIMATELY 50 FT ABOVE, AND 50 FT BEHIND THE LEADER OF THE LEAD SECTION. ALL A/C IN A SECTION ARE AT THE SAME LEVEL. ALL A/C HAVE A CLEARANCE OF 250 YDS, WING-TIP TO WING-TIP.

A GROUP



A GROUP : 48 A/C.

3 SQUADRONS, A LEAD, A HIGH AND A LOW. THE HIGH SQUADRON FLIES APPROXIMATELY 1000 FT. ABOVE THE LEAD SQUADRON; THE LOW SQUADRON FLIES APPROXIMATELY 750 FT. BELOW THE LEAD SQUADRON. THE WING SQUADRONS FLY A FEW FEET BACK (± 50 FT.) IN ORDER TO GUIDE ON THE LEAD SQUADRON.

TO THE LIMIT OF THEIR ENDURANCE

(CONTINUED FROM PAGE 50)

miles from base), where both bombers and fighters landed at Russian bases. Later the fighters shuttled down to Fifteenth Air Force bases in Italy, then escorted a bomber mission back again to bases in Britain.

Beginning in August 1944, bomber boxes became smaller and columns longer. Now more fighter units were necessary. With strength per group increasing to 85 and 90 aircraft, fighter groups met this need by slicing operational units in two, building "A" and "B" groups with upwards of 24 aircraft each, each having its own Air Commander. The split increased flexibility of escort, allowing a combination of close support by part of a group

and sweeping tactics by the other part. Heavy losses were inflicted on the Luftwaffe which found it increasingly expensive to attack the bombers through our fighter defense. Eventually the Hun lapsed into the general practice of attacking the heavies only when they became scattered or while fighter escort was absent.

Microwave Early Warning control was moved in November 1944 from the English coast to Culven, Holland (west of Aachen) and gave our fighters additional "eyes" further into enemy territory. Deeper enemy concentrations, disposed to protect Germany's industrial vitals, were now much more vulnerable inasmuch as Microwave Early Warning controllers could vector our fighter groups onto enemy concentrations within an effective range of some 165 miles

from the Microwave Early Warning site. Coupled with "Y" information, Microwave Early Warning gave fighter controllers remarkable knowledge of the progress of enemy interception.

All this time the swarm of P-51's multiplied. In September 1944, the P-38's were replaced; by October most of the P-47 groups had switched to P-51's. December saw the entire Fighter Command operating P-51's except for the 56th Group which retained P-47's. The switch-over caused notable gains in range and in actual number of escort hours. It was the final phase in the transformation of a fighter force having primarily a protective escort function, into a much more versatile one possessing offensive and harassing capabilities as well.

TYPES OF ESCORT

The Eighth Air Force gave Group Commanders ample freedom in deciding how they would employ their fighters on escort missions. However, three basic types of fighter escort were used:

- (1) close or direct support,
- (2) area or indirect support, and
- (3) a combination of both.

Close Support

Fighter range is reduced considerably on escort duty because fighters must weave to stay with the slower bombers. Even though fighters flying alone have enough range to go directly to a target area and return from a deep penetration, the necessity of weaving drastically reduces their range.

To overcome this difficulty in connection with Eighth Air Force missions, a "relay system" of fighter escort was planned in which one group of fighters would pick up the bombers

as soon as they reached enemy territory and escort them for roughly 150 to 200 miles. About five minutes before the fighter group reached its range limit another group, flying directly from base to a pre-arranged rendezvous point, would furnish relief. Again when the second group reached its limit a third would take over. The relay system, with relief coming practically every hour, would continue until the bombers were back over friendly territory.

Area Support

This method was usually employed when the bombers left England in small groups, or when the bomber stream would split into small units after entering enemy territory. To supply continuous close support under these conditions would be difficult with the limited number of fighter groups available.

Area support enabled the fighters to patrol the areas through which the bombers would pass or in which they bombed. By arriv-

ing in their assigned areas in advance of the bombers, fighter groups could engage enemy aircraft attempting to form up for interception.

Combination Area and Close Support

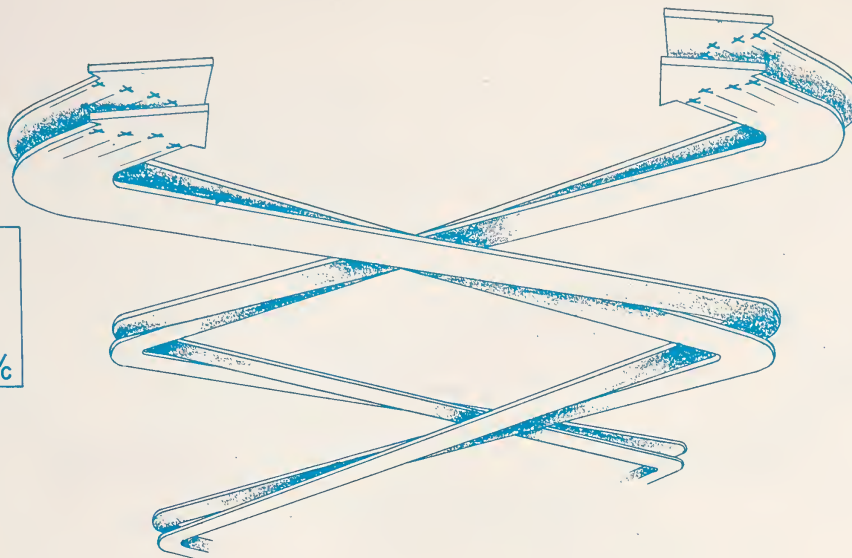
Combination area and close support was used on missions in which a large number of bombers would proceed from England as a single force deep into enemy territory and then would separate into small units to attack many targets.

The deeper distances involved precluded area support along the entire route. Limited numbers of fighters made it impracticable to assign close support to each small unit of bombers in the target area. Close support therefore, would be provided while the bombers flew as a single force, and additional fighter groups, arriving in advance of the heavies, would cover the target areas. They would remain until the bombers cleared the area. As the bombers reassembled into a single force, close support would again be provided for the return trip.

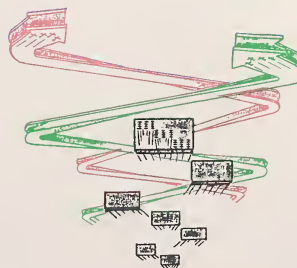
FIGHTER ESCORT

DIAGRAM 2

SQUADRON 5 MILES
AHEAD and SLIGHTLY
ABOVE BOMBERS TO
STOP HEAD ON
ATTACKS by ENEMY $\frac{A}{C}$

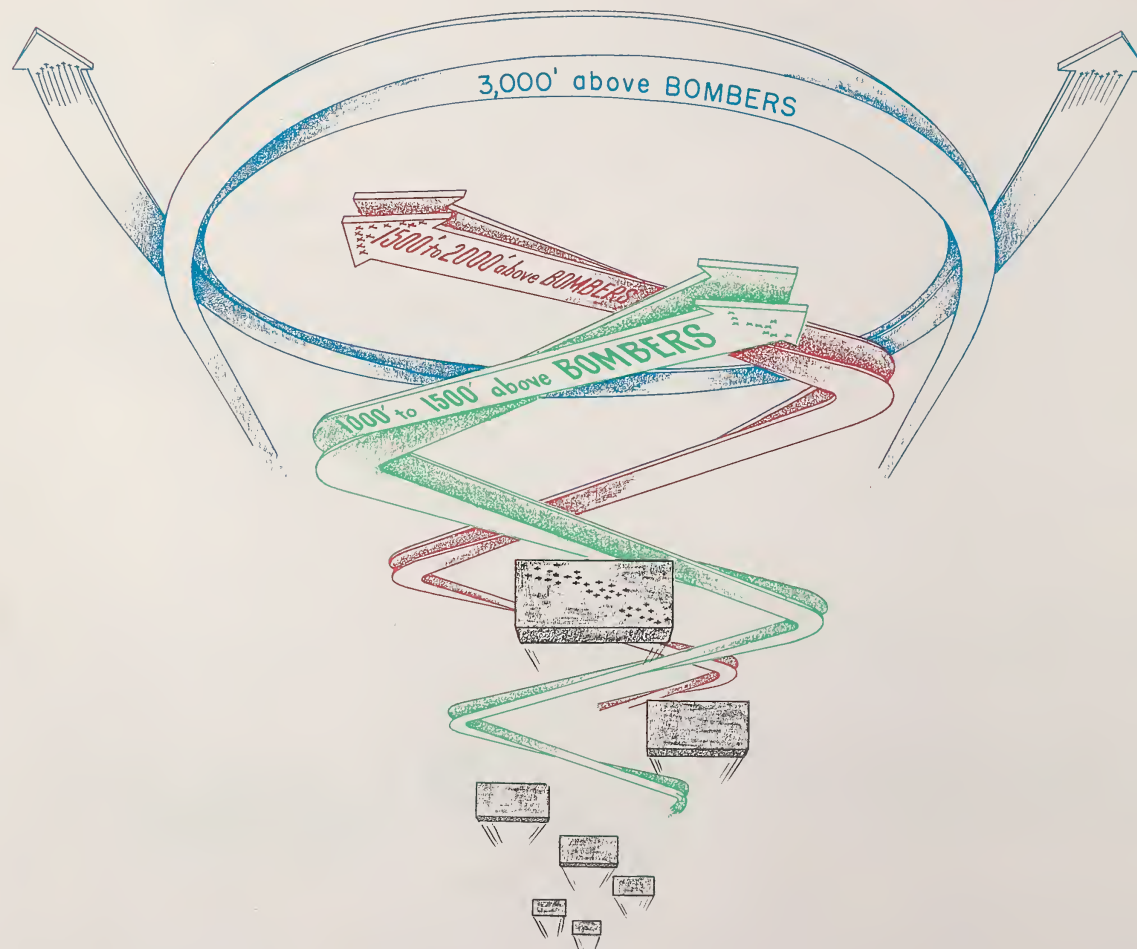


SQUADRON
1,500' ft. to 2,000 ft.
ABOVE BOMBERS



SQUADRON
1,000 ft. to 1,500 ft.
ABOVE BOMBERS

BASIC TYPE of ESCORT EMPLOYING 3 FIGHTER SQUADRONS. FLIGHTS CROSS OVER ON TURNS TO COVER EACH OTHER AGAINST TAIL ATTACK. SECTIONS and SQUADRONS CRISS CROSS FOR MUTUAL PROTECTION.



BASIC TYPE of ESCORT EMPLOYING 3 FIGHTER SQUADRONS. SECTIONS and SQUADRONS COVER EACH OTHER AGAINST TAIL ATTACKS

FIGHTER ESCORT

A: BASIC TYPE of ESCORT
EMPLOYING 3 FIGHTER
SQUADRONS.

SQUADRON 5 MILES
AHEAD and SLIGHTLY
ABOVE BOMBERS TO
STOP HEAD ON
ATTACKS by ENEMY $\frac{A}{C}$

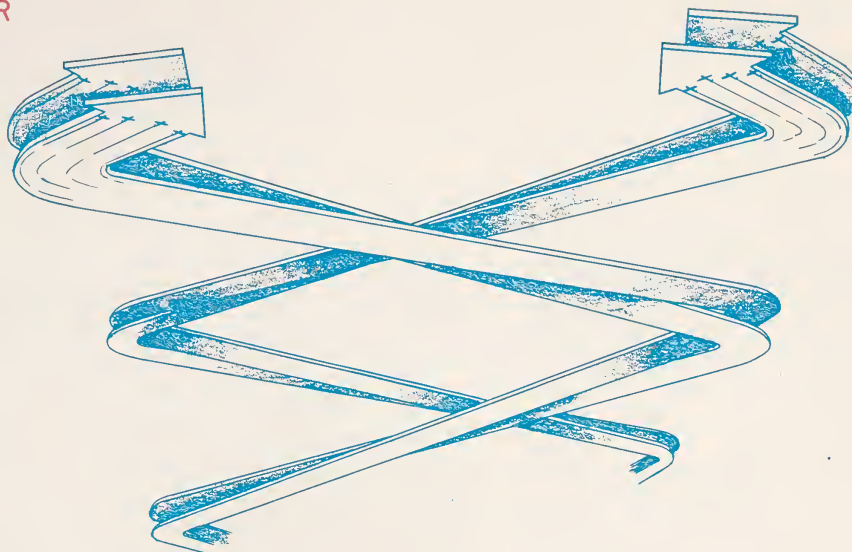
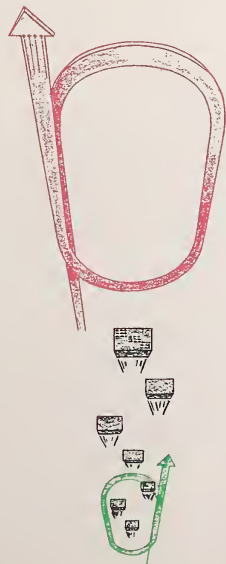


DIAGRAM 4

B: BASIC TYPE of ESCORT when
only 1 FIGHTER SQUADRON is
AVAILABLE.

LEAD SECTION FLIES 2,500'
ABOVE FRONT of BOMBERS.



REAR SECTION FLIES 2,500'
ABOVE REAR of BOMBERS.

HIGH SECTION
1,000' to 1,500'
ABOVE BOMBERS



LOW SECTION
500' to 1,000'
ABOVE BOMBERS

SECTIONS FLY ON EACH SIDE OF BOMBERS
OUT OF RANGE OF MACHINE GUN FIRE.
(over 3,600')

FIGHTER STRAFING

The doctrine of "ultimate pursuit" of enemy fighters, initiated in January 1944, encouraged our fighters to attack enemy airfields, transportation, and other ground targets while returning to base. The success of these low-level operations prompted the planning in March 1944 of two full-scale strafing offensives: Plans "Jackpot" and "Chatanooqa Choo Choo".

For purposes of these plans, Germany was divided into halves. Each half, again was subdivided into 15 areas. This gave each fighter group two areas for study and briefing. Plan "Jackpot" covered attacks on enemy aircraft on the ground within the prescribed areas; Plan "Chatanooqa" for attacks on locomotives and transport. Neither of these plans was fully exploited. Only when weather prevented bomber operations were the fighters free to execute them. On the few occasions when the plans could be put into effect, striking successes resulted.

D-Day and the beach-head period following, witnessed the climax and maximum use of Eighth Fighter Command as an independent striking force. Areas of patrol were established, ringing Normandy as far south as the Loire River. Fighter groups, sub-divided into "A" and "B", and even "C" units, patrolled these areas as well as the adjacent shipping lanes during all the daylight hours. Although their primary mission was to prevent aerial attack on our ground and sea forces, stoppage of enemy rail and road movement for reinforcement and resupply of the German Army eventually became the major objective. This phalanx of fighters made it impossible for the few aircraft risked by the Luftwaffe to launch any attacks upon our

invasion forces. Stoppage of enemy rail and road movement toward the battle area was so effective as to cause the German High Command, first, to abandon use of the principal highways and, later, all movement during daylight hours.

Radar-assisted ground control was impossible at the distance our fighters operated from England. So was radio contact with our controllers, except through airborne relays. British Ground Control Interception radar was always available to our ground fighter control, but was effective only within approximately 100 miles of the English coast. British "Type 16" radar increased this range slightly and was more accurate, but still possessed only limited range. Microwave Early Warning became available to Eighth Air Force in the summer of 1944, but not until late November of that year, when it was moved to Gulpen, Holland, was ground control in depth possible.

On November 27th, 1944, ten fighter groups were assigned to attack airfields in North-central Germany under Microwave Early Warning control. Five other groups were escorting small bomber forces in the Frankfurt area. From "Y" Service it was learned that the Hun controllers, after plotting the bomber assembly over East Anglia, mistook the incoming force of P-47s and P-51s for four-engine bombers. The day before, our bomber penetration over the same northern route had evoked strong enemy fighter reaction. Again the Luftwaffe rose in maximum effort. Only this time the enemy encountered a hornets' nest of fighters, while the heavies, completely unmolested, attacked targets in southwest Germany. Skillful vectoring by Microwave Early Warning, plus the enemy's fatal mistake, resulted in claims of 98-4-11 out of

250 - 350 German fighters engaged. Three P-51s were lost to a decidedly unaggressive enemy. Nor did these air battles prevent our fighters from completing their strafing and bombing with notable success.

By January 1945 impromptu strafing was forbidden because the fighter losses incurred were not worth the few targets available. In the last 30 days of the war, however, the fading, fuel-less Luftwaffe was so concentrated in its few remaining airfields as to provide ideal conditions for specific strafing missions. Ground claims for the month of April reached the enormous total of 1791-0-1073.

Strafing Technique

These astonishing results were achieved by a technique which, with variations from group to group, was basically this:

The attacking group would come in on the deck to avoid detection and flak, pulling up to 1,000 feet about a mile from the target. The first squadron would continue to climb, and then circle the airfield at 3,500 feet to provide top cover. The second squadron would strafe gun emplacements and anti-aircraft batteries. The third or rear squadron would attack airfield installations and parked aircraft.

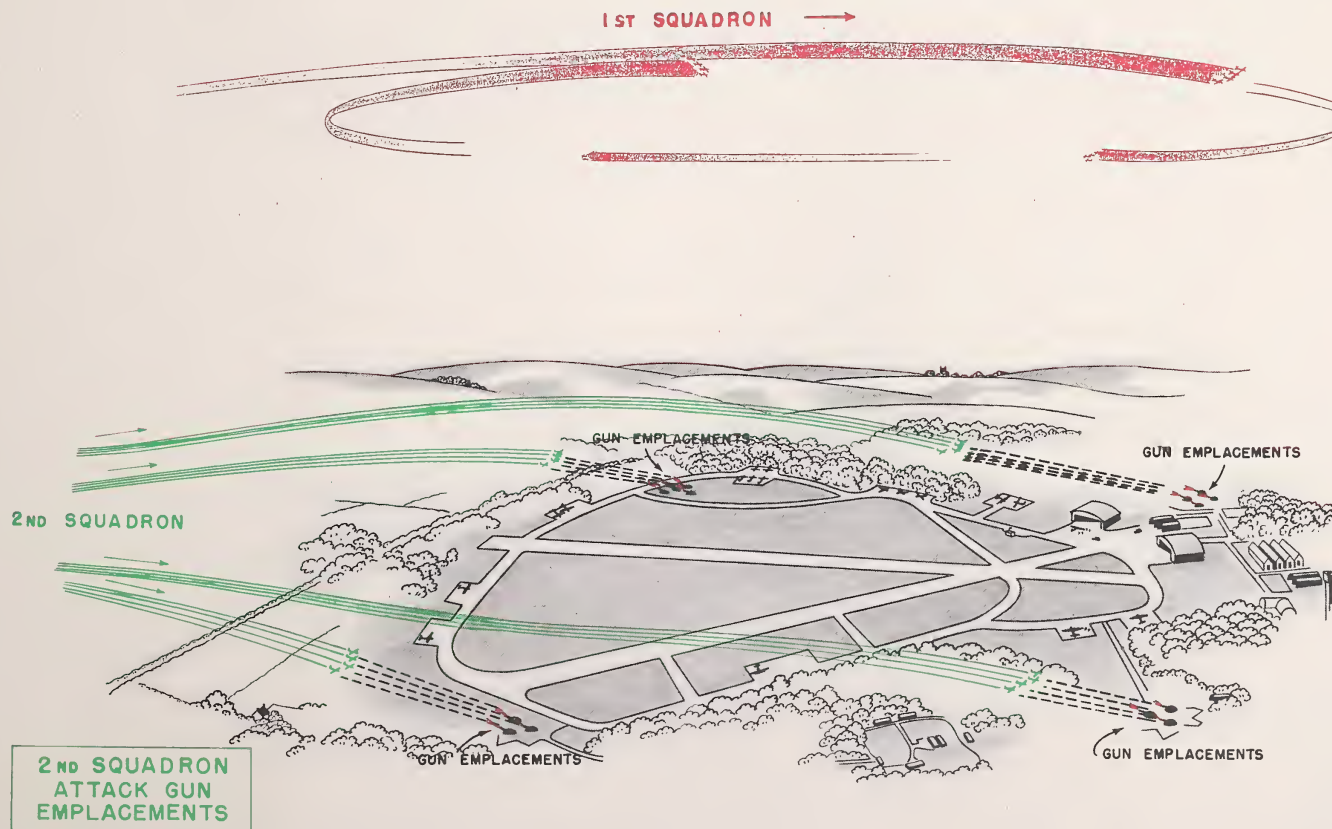
The second squadron would then relieve the first as top cover. This would enable the latter to go down and strafe those installations untouched by the second and third. Upon order from the air commander all squadrons would escape at deck level to reform at a briefed rally point.

STRAFING

FIRST STAGE of STRAFING AN ENEMY A/D

DIAGRAM 5 (Part I)

1ST SQUADRON AFFORD
COVER BY CIRCLING
A/D AT 3,500'



STRAFING

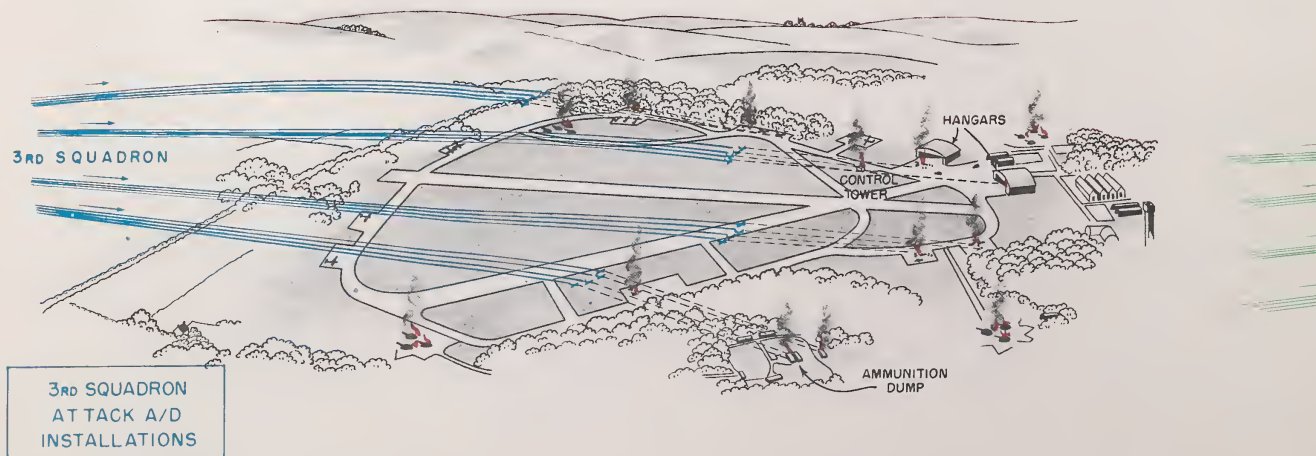
SECOND STAGE of STRAFING AN ENEMY A/D

DIAGRAM 5

(Part 2)

1ST SQUADRON
CONTINUES TO
CIRCLE A/D

1ST SQUADRON



STRAFING

THIRD STAGE of STRAFING AN ENEMY A/D

DIAGRAM 5 (Part 3)



FIGHTER BOMBING

The use of high-altitude-escort fighter aircraft for fighter bombing was pioneered by Eighth Air Force. After much training and practice, during which experience of the individual pilot had to compensate for the absence of dive brakes and proper bomb sights, two P-47 groups flew a coordinated mission.

On 25 November 1943, the 56th Group, forming behind a B-24, dropped 10.75 tons from 24,000 feet on an airdrome at St. Omer in the Pas de Calais.

Then the 353rd Group, diving from 14,000 feet, released 3.5 tons at 8,000 feet on the same target.

Fighter bombing continued with varying success against airfields and transportation targets, but it never became a major activity of the Eighth because not enough time was available from escort duty to permit adequate training.

During the Normandy beach-head period, P-47 groups consistently dive bombed road and rail opportunity targets. And from the fall of 1944 on, intermittent attacks were made on enemy airfields and railroad bridges by P-38's and P-51's as well as P-47's. However, dive bombing forays against airfields had only nuisance value; those against railroad bridges were on the whole unsatisfactory. Neither evoked much opposition from the Luftwaffe.

By modifying some of the P-38's to allow carrying of a bombardier and bomb sight, a high level bombing technique called "Droop Snoot" was developed. The 20th and 55th Groups first undertook "Droop Snoot" on 10 April 1944, dropping a total of 27 tons on Gutersloh and Coulommiers airfields with very satisfactory results. Heavy flak was the most dangerous enemy threat to this type of fighter bombing, but with practice a loose formation could be flown to the start of the bomb run, then tightened for only 30 seconds until all aircraft dropped on the "Droop Snoot".

Bombs away! was the signal to break up the formation. Because of the compact formation on the bomb run a tight bomb pattern resulted.

Low-level skip bombing was also tried. Bombs or partially filled wing tanks were skipped against enemy targets. The tanks were then kindled by incendiary ammunition from succeeding flights, but the high degree of skill necessary for the delicate timing of this operation was difficult to acquire in the time available. So success varied.

Losses from fighter bombing were proportionately more severe than those suffered on regular escort missions. Enemy light flak, automatic weapons and small arms fire from the well-defended objectives, shot down valuable pilots previously unscathed in aerial combat. This fact, plus the eventual shift to the more vulnerable P-51, resulted in the decision to abandon fighter bombing except in rare instances.

CHAPTER III

BOMBING

BOMBING

During operations over Nazi-occupied Europe, the Eighth Air Force bombed 1675 targets in twelve countries.

This impact - coupled with that of the Royal Air Force, the Fifteenth Air Force, and all the Tactical Air Forces - shattered the German war potential; it was a major factor in the swift advance of Allied armies through the Reich. It is interesting to note that Rundstedt placed Allied air superiority as the number one reason for Germany's defeat. Next in order, he placed destruction of the oil industry, in which the Eighth Air Force played the major part, and dislocation of Germany's transportation system by bomber and fighter-bomber attacks, in which the Eighth Air Force played an important role.

Reichminister of Armament and War Production Albert Speer confirms this with admissions of the telling effect of daylight precision bombing upon German industry; the fuel shortage which seriously hampered operations of the Wehrmacht and Luftwaffe; the breakdown of the transportation system which made it impossible to deliver produced armaments to those spots where they were needed most.

Thus, in its first great trial, it was demonstrated, and the Germans confirm that daylight precision bombing had met the test. Met the test despite many limitations to the application of the bombing effort. What were the factors responsible for these limitations and how did they affect the overall accomplishments of this Air Force?

Targets and Capabilities

The decision of the Joint Chiefs of Staff to invade Italy slowed up the development of the Eighth Air Force. Until the end of 1943, the delivery rate of new bomb groups and replacement aircraft to Eighth Air Force was well behind schedule. Such retarded expansion was accentuated by the relatively small load per bomber.

It was not possible to achieve the depth of penetration desired in the fulfillment of our target commitments before 1944. We were limited by the size and range of our escort

force relative to the strength of enemy opposition. By venturing too far beyond escort range, we suffered such heavy losses that it was necessary to bomb shallow targets for a period thereafter.

Weather, also had its limiting effect. Up to 1944, the necessity for visual bombing conditions severely restricted the number of days when base, route, and target weather favored bombing missions. Early in 1944 sufficient overcast bombing equipment had arrived to increase the number of missions flown. But overcast conditions still limited the selection of targets to those recognizable with the new equipment.

Flak was an omnipresent hazard. In the Ruhr, for example, the huge concentration of anti-aircraft guns made visual bombing very costly. For that reason, a few valuable precision targets which might have been hit there visually were seldom bombed. Furthermore, the Royal Air Force hammered the Ruhr at night with great bomb tonnages, destroying areas which the Eighth could not attack until overcast techniques became more reliable.

Before, during, and after D-Day, tactical bombing absorbed a great part of our effort. Huge tonnages were expended in attacks on marshalling yards, bridges and airfields adjacent to the battle areas, as well as in direct cooperation with our ground troops.

In summary, then, the depth of penetration possible, weather, flak and tactical bombing, imposed great limitations on the fulfillment of target commitments.

Accuracy

Accuracy achieved during operational training in the United States fell off considerably after groups began to bomb enemy targets under combat conditions. Five factors contributed to this falling off (1) navigation to and identification of the Initial Point (2) formation bombing (3) combat conditions (4) target recognition (5) nature of the bomb run.

In the United States, bombardiers had been trained to bomb on individual runs for accuracy. Now the necessary emphasis on defense required

bombing in formation with a resultant reduction in bombing accuracy. In order to improve this situation, many changes were made in the formations flown. The first significant change was to bomb by formation with the leader sighting for range and deflection while the wing men sighted independently for range. Later, the entire formation bombed as a unit with only the leader sighting.

Early in the war, the tendency was to drop with a large formation. Gradually, smaller and smaller formations were adopted (Chapter I). For visual attacks the final result was squadron bombing. For overcast attacks, the nature of the target, enemy opposition, and the availability of overcast bombing equipment determined the formation size.

Bomb patterns were improved by varying the shape of the formation. The tendency was to get more and more compact squadrons in order to obtain a denser bomb pattern.

Both flak and enemy fighters reduced the accuracy of our bombardiers compared to training standards. Harassing attacks by enemy aircraft made it difficult to concentrate on bombing. If the lead bombardier was shot down, the deputy aircraft would have to take over in a minimum of time under heavy pressure. This mental hazard coupled with the inefficiency of operating under oxygen and heavy personal equipment, were definite disadvantages. The accuracy of enemy anti-aircraft fire normally required our formations to bomb from heights around 25,000 feet despite the fact that bombing accuracy decreased in direct proportion to altitude. Early experiments with bombing from 7,500 and 8,000 feet resulted in such heavy flak losses that, as a rule, the Eighth Air Force never thereafter bombed heavily defended targets from low altitude.

Because of poor visibility, and location in built-up areas, targets were harder to recognize over Europe than practice targets in the United States. On many targets, recognition was nearly impossible. Not only did the bombardiers have to contend with clever camouflage and thick smoke screens thrown up by the enemy, but often the dust and smoke from our own bombing hid targets from units arriving

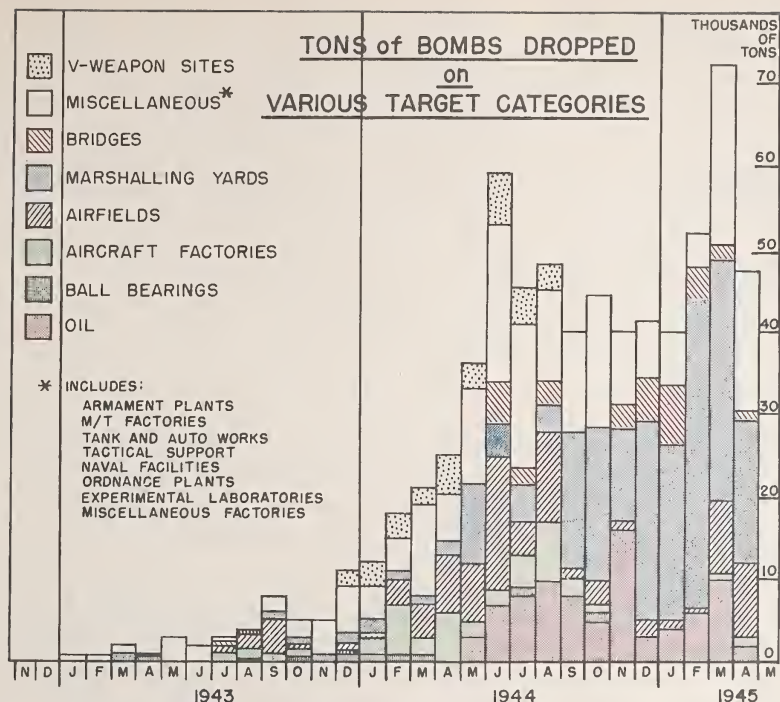


Chart A. During operations over Nazi-occupied Europe, the Eighth Air Force dropped a grand total of 696,450 tons on 1,575 targets. The above chart shows the tonnage dropped each month on various types of targets.

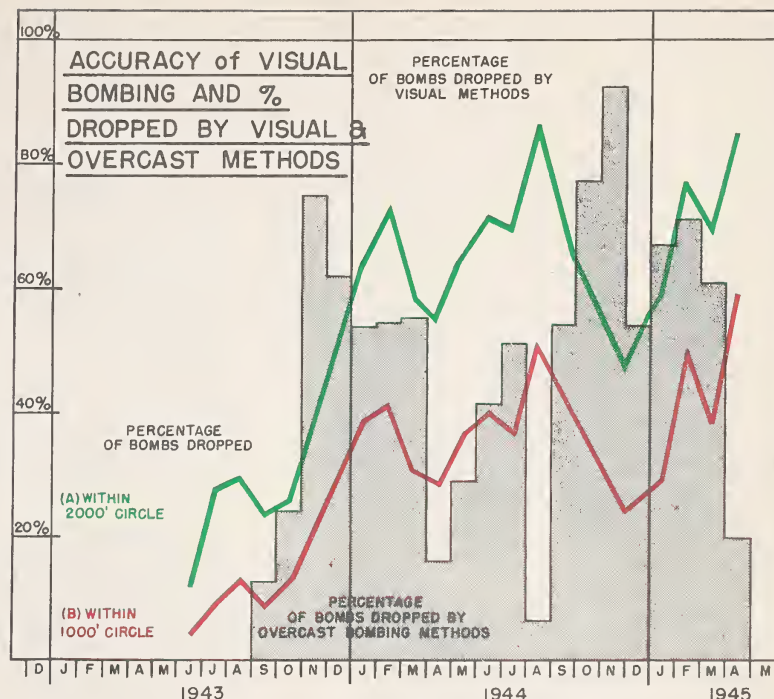


Chart B. The above chart shows the percentage of visual and overcast bombing for each month, and the accuracy of visual bombing in terms of the percentage of bombs dropped within 1,000 and 2,000 foot circles around the targets attacked.

BOMBING (CONT'D)

later.

The direction of the bomb run was frequently an adverse factor to bombing accuracy. Was the sun in the right position for the run? Could the direction of the wind enable formations to race across flak defenses with minimum hazard in spite of the fact that down-

wind bombing reduced accuracy compared to up-wind? That had to be weighed against the favorable fact that down-wind bombing blew away dust and smoke from oncoming units.

The exact direction of target attack was usually a compromise between wind-direction (both surface and at altitude), position of

the sun, location of the heaviest anti-aircraft defenses, pattern of smoke screens, target identification features, and the routings and headings of the other units or forces.

This compromise, plus navigation and traffic problems, explains why bombing accuracy under combat conditions was necessarily less than on practice runs in the United States.

OVERCAST BOMBING

GENERAL STATEMENT

Weather in this theater was the most important limiting factor in operations when the Eighth Air Force began to fly from England. To begin with, we were grounded four out of every five days because visual bombing conditions were lacking. There was great need to find some means to utilize non-visual days.

Much thought had already been spent on this problem in the United States. Some procedures had been devised. The British had experimented with radar to locate targets through cloud with limited success. Their device was called H2S and, with it bodies of water could be distinguished from land, and cities could be found. But pinpoint targets were impossible to locate.

The Eighth Air Force experimented with British H2S. It was a distinct aid to navigation over cloud but was not nearly selective enough for accurate bombing. As a result of experimentation, an American device was produced, called H2X. This was an improvement over H2S but still was incapable of distinguishing small targets. But H2X soon increased our capabilities to a marked degree.

There were some targets of an industrial nature each of which was situated at the side of a large city. The city could be located on the H2X scope. By approaching the city from the appropriate direction, the target could be bombed by aid of its known distance and direction from the center of the city. Sometimes a huge industrial plant would make a "blip" of its own on the scope which could be distinguished from the main "blip" made by the city.

Other targets might be located on a shore

line. If the shore were irregular in shape so that a landmark would appear in the scope, the landmark would aid in locating the target.

In general, H2X could not locate the average pinpoint target, but it could locate enough area targets through the overcast to increase our capability of bombing to a marked degree. In addition, it was of great value in locating targets on visual days by aiding in the finding of check points and correcting navigation over cloud on the way to the target.

A great advantage of H2X is the fact that it is self-contained on the aircraft. This only limits the range of its utility to the range of the aircraft. Many other navigational and bombing devices are "tied" to ground transmitting stations which send out the radar pulses which actuate the scopes in the aircraft. Since radar rays travel in a "line of sight", they gain in altitude over the ground as the distance from the station results in more and more curvature of the earth. Hence, radar ground stations can only reach aircraft at greater altitudes with greater distances from the transmitting station.

Adaptation of another British navigational instrument resulted in the American navigation device called Gee-H. Its scope was actuated by two ground transmitting stations. With this device the aircraft could know its own location over the ground with more or less accuracy, depending on the distance from the transmitting stations. Techniques were developed to use this navigation device for bombing. Marked success resulted, even in bombing small targets.

Another instrument, called Micro-H, was devised along similar lines but was more

accurate than Gee-H. It was limited in range to around 170 miles from the transmitting stations when the aircraft was at 20,000 feet, and 200 miles when at 25,000 feet. With proper techniques, this device was found to have several advantages over Gee-H.

The accuracy of bombing by Gee-H and Micro-H continued to improve as crews became better trained and more experienced. The small supply of equipment was a limiting factor in their use. But techniques of bombing-on-the-leader permitted the few instruments to give capability of bombing through the overcast to a large number of aircraft.

During the war with Germany, Gee-H and Micro-H never attained the accuracy of visual bombing. But their use greatly increased our operating capabilities within their range. When territory on the Continent of Europe could be used, transmitting station sites there gave Gee-H and Micro-H sufficient range to reach important targets in Germany.

By the use of all three devices, H2X, Gee-H and Micro-H, we were able to operate on a high percentage of days instead of the few which would permit visual bombing, and targets suitable for each type of device could be hit with a profitable percentage of bombs. Also, they permitted us to initiate an operation for overcast bombing, only to discover upon arrival at the target that cloud had unexpectedly cleared. This would permit us to bomb visually on a day which otherwise would have been lost.

An important additional advantage of overcast bombing was the factor of loss. The cost to our force in aircraft lost, both to enemy fighters and to flak, was constantly much lower on overcast days than it was in clear weather.

1. H2X

On D-Day, overcast covered the invasion beaches. Yet Eighth Air Force bombed its targets successfully without hitting the ships close to the beach or the troops inland. They did it by H2X.

H2X is airborne radar. It transmits high frequency electrical impulses downward through a revolving antenna. These impulses are reflected back to the antenna by various objects on the earth. The H2X set converts these reflected impulses into light patterns on the scope of the set. By matching these patterns with scope photographs of the actual invasion coast, the bombers were able to hit their narrow target with satisfactory results.

Months of experimentation, training, and combat experience achieved that D-Day bombing success. Back in June 1943, twelve hand-made H2X sets were installed in B-17s as navigation aids. The first actual bombing mission was flown the following October. But not until February 1944 did the first production sets arrive. In April, in a special school at Alconbury, Huntingdonshire, began the first theater training of operations for H2X bombing. Outstanding navigators attended this four weeks course which later enrolled H2X operators who had received previous training at Langley and Boca Raton in the United States. While these men learned to operate the sets, Group Intelligence Officers busied themselves with the theory and practice of H2X and the interpretation and plotting of scope photographs.

By April 1944 serious thought was given to improving H2X bombing accuracy through the use of the Norden bomb sight and the automatic pilot in conjunction with the H2X set. Tables were prepared for converting distance into sighting angles for the bomb sight. Eventually the sighting angles were added to the H2X computer drum. Now the H2X operator could furnish the bombardier with data on ground speed, drift, and distance for every mile until the aircraft was within four to five miles of the target. Without further correction the bombsight did the rest, releasing the bombs when the indices met.

On a completely visual day the H2X operator could set course and get the bombsight approximately synchronized at a greater distance from the target than the bombardier could with his sight. In a partial overcast the H2X operator could continue to direct the bombsight settings until the bombardier took over with a last minute visual sighting and made minor adjustments.

The coordination method is also the best for bombing through a complete overcast. A number of check points are chosen along the penetration route. As the aircraft flies over each one, the H2X operator identifies them in his scope and transmits the data to the bombardier who makes the necessary adjustments in his bombsight. When the aircraft is about twelve miles from the target the H2X operator transmits a final check. Now the aircraft is moving toward the target along a definite track. The bombardier transposes these computations into a dropping angle which is set in the bombsight. When the indices meet, the bombs release automatically. If a break in the clouds occurs, a visual sighting at the last minute is possible and minor corrections can be made.

This was the technique used on D-Day. Eighteen to thirty-six aircraft were flown abreast with the H2X aircraft in the center of the formation. H2X operators carried maps and scope photographs of the invasion coast. Long familiarization with vertical and scope photographs of the English and French coast lines enabled them to identify the shipping and shore-line patterns in their H2X scopes.

These photographs had been taken by K-24 cameras installed at the remote scope of the H2X set. All negatives were developed by the 325th Photographic Wing Reconnaissance at Eighth Air Force Headquarters. The best prints were then redistributed to all H2X groups which compiled a basic list of photographs for use in briefing, interrogation, target study, and navigation. In December 1944 it was decided to replace K-24 cameras with 16 millimeter motion picture cameras.

The Oxford Experiment.

The success of D-Day raised the question as to whether it was possible to pick out a precision target in a built-up area and bomb it with satisfactory accuracy by H2X. Such a mission was prepared against an oil refinery in Bremen on 24 June 1944. Scope photographs of the area showed that the location of the refinery could be established by the shape of the built-up area. Although the operation was not a complete success, photographic reconnaissance showed that several wings, which did bomb as briefed, dropped good tight patterns close to the target. This demonstrated that it was possible to locate an assigned area within a town, rather than aiming for the center of the town. Synchronous bombing technique made this possible. By lining up bomber formations at a

much further distance from the target than formerly, bombsights could be approximately synchronized before the bombardiers could pick up the target visually. In this way a tighter pattern was obtained with less chance of error.

In August and September 1944, two B-17 combat crews, simulating combat conditions, used the synchronous bombing technique in practice bombing runs on two targets in Oxford - the center of the city and an industrial plant on its edge. The purpose of the test was (1) to determine the capabilities of H2X equipment under these controlled conditions so as to provide a realistic standard of performance to strive for under combat conditions, and (2) to isolate causes of error which are dependent on combat conditions.

Assessment of results obtained on 310 bombing runs made at 18,000 and 25,000 feet with a bombing run of 28 miles led to these outstanding conclusions:

- (1) H2X can be used with a reasonable degree of success against city areas or isolated industrial complexes.
- (2) Average bombing errors bear little relation to the inherent capability of the H2X set.
- (3) Chance of hitting an industrial target within the built-up area of a city with any reasonable bombing force is extremely slight.
- (4) The degree of accuracy obtained in practice bombing cannot be expected in combat bombing.

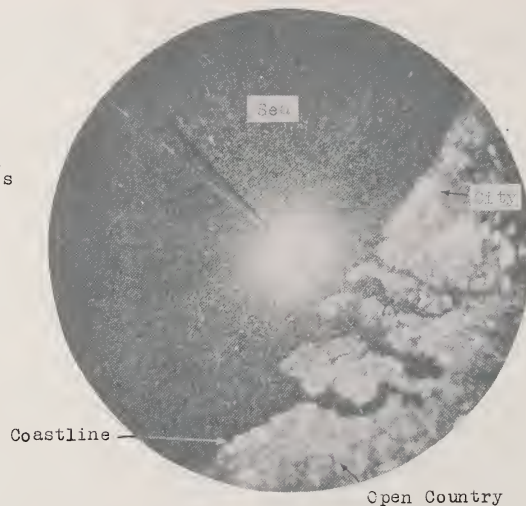
Type of target, altitude, ground speed, target study, adjustments and calibrations of equipment, synchronization and setting and personnel performances were listed as the outstanding factors affecting the accuracy of H2X bombing.

In the combat missions that followed it was found that one out of every four H2X sightings proved to be ineffective because of H2X equipment failures. Moreover, there was a striking correlation between the degree of cloud cover on the bombing run and bombing errors. Even a small break in the clouds enabled the bombardier to synchronize his bombsight with considerable accuracy, and thus improve the bomb pattern.

H2X is airborne radar. It transmits high frequency electrical impulses through a revolving antenna. These impulses are reflected back to the antenna by various objects. The H2X set converts these reflected impulses in to light on the "scope" of the set as shown at the right.

The direction in which the antenna points determines the bearing of a reflecting object, while the time interval between transmission and reception of the impulse determines its range. The pattern made on the scope indicates the distance and bearing of the reflecting object from the aircraft.

The diagram below shows various types of reflecting surfaces, and the comparative intensity of the reflection returned by each.



Coastline

Open Country



- ← Ship - Small bright return in large number of small angles to path of rays.
- ← Position directly beneath A/C most nearly at right angles to surroundings.
- ← Rays giving strong returns.
- ← All rays reflected away from A/C producing negative returns.
- ← Sea - All rays reflected away from A/C producing negative returns.
- ← Open Country - Moderate returns due to rough surface resulting in large number of small angles to path of rays.
- ← Residential Areas - Strong returns due to rough surface resulting in large number of small angles to path of rays.
- ← Industrial Areas - Very strong returns due to corner reflection.
- ← Mountains - Very strong returns due to rough surface resulting in large number of small angles to path of rays.
- ← Rivers and lakes - Varying degrees of moderate returns.
- ← Rough country - Varying degrees of moderate returns.
- ← Ridges - Alternate high lights and shadows.
- ← Negative returns from face which is away from A/C.
- ← Returns from side construction with increased possibility for corner reflection.
- ← Returns due to smooth angular construction with increased possibility for corner reflection.

Corner Reflection

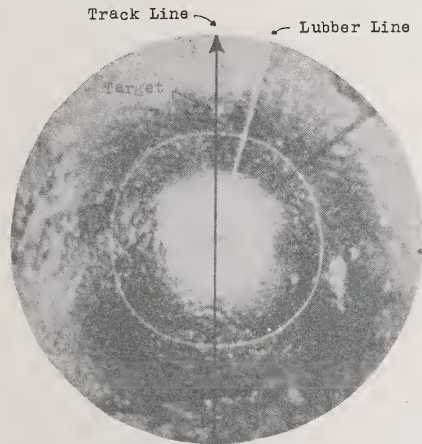


Rays emerge parallel to entrance.

BOMBING

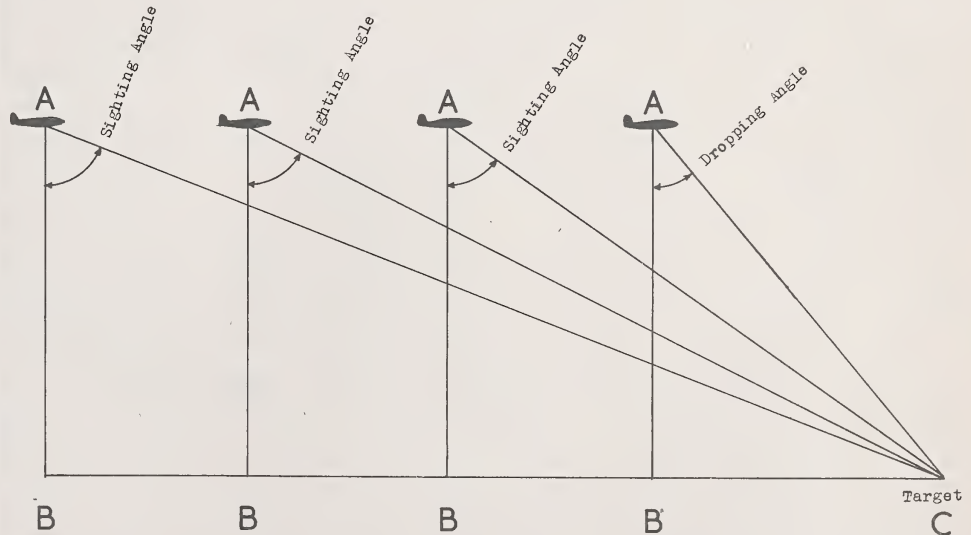
As in all bombing, the two primary considerations in H2X bombing are deflection and range.

DEFLECTION



Lubber line indicates heading of the aircraft. The track line indicates the actual path of the aircraft over the ground. When the target travels along the track line, the aircraft will cross the target. Since a released bomb will continue along this line, the track of the aircraft must cross the target. Corrections to meet this condition must be started approximately 40 miles from the target and completed before the aircraft is 12 miles from the target.

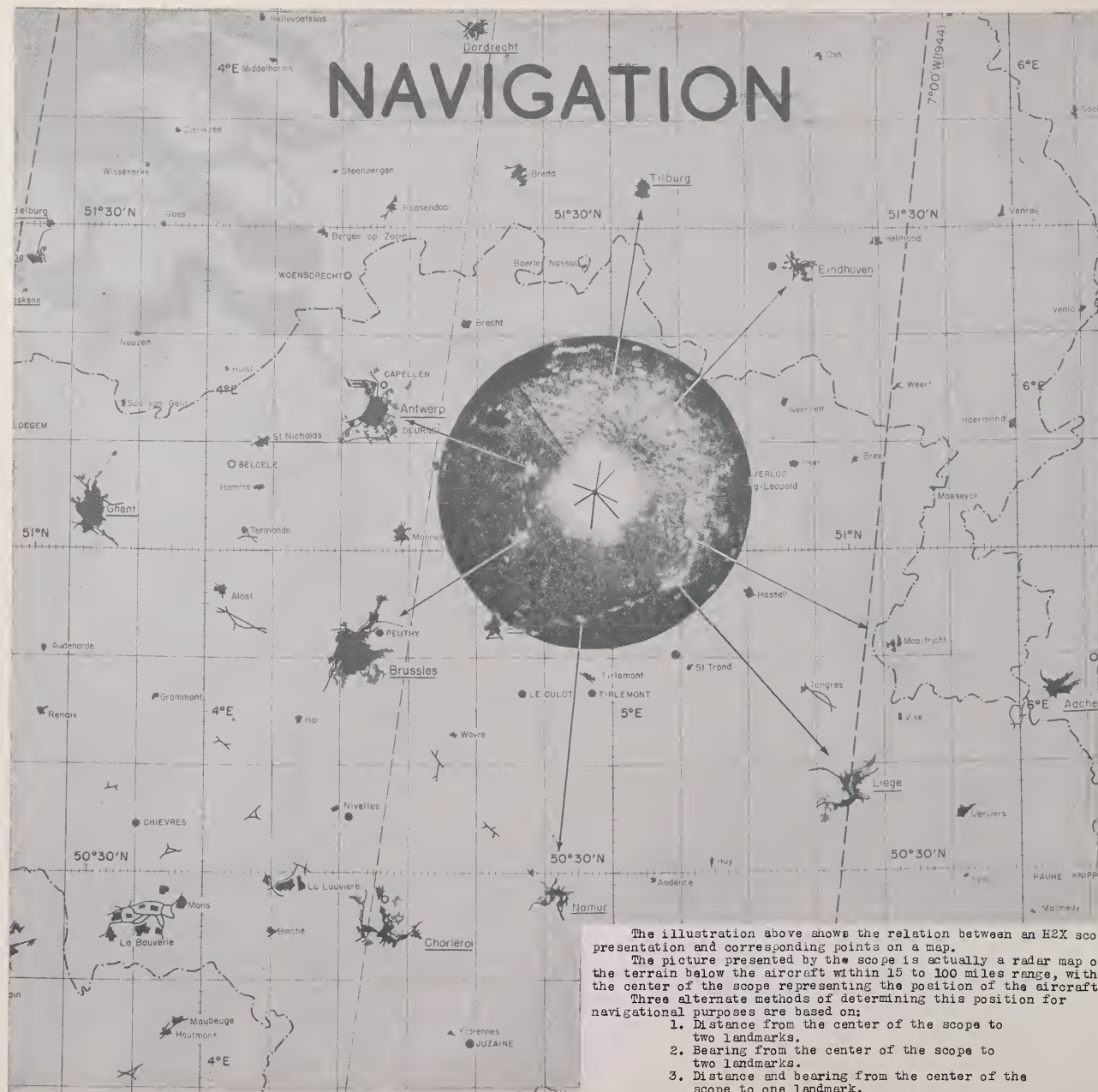
RANGE



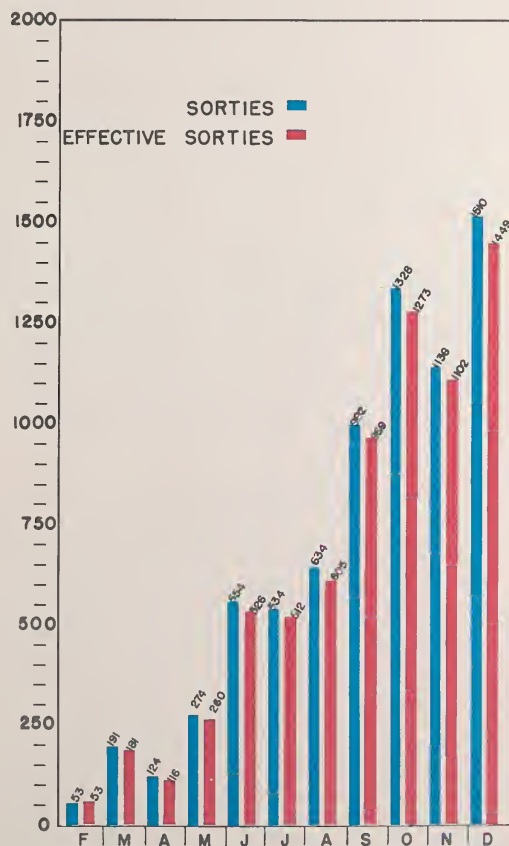
Due to forward travel of bomb after release, the release point must occur on the track line before the aircraft reaches the target. This distance is computed by the bombardier, and transposed into a dropping angle which is set into the bombsight.

Altitude and distance to the target (AB and AC in the drawing above) are measured by the H2X operator. The ratio between these distances determines the sighting angle (angle of tilt of bombsight telescope).

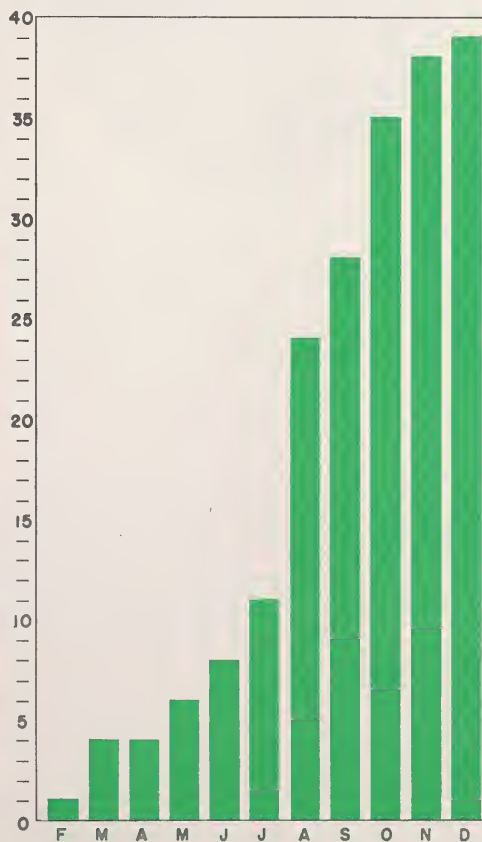
Periodic measurements are made by the H2X operator, and mechanically converted into sighting angles which are used to check the synchronization of the bombsight. With this procedure, the bombsight telescope is always on the target. If a break in the clouds occurs, the bombardier can then take over for a visual sighting, and only minor corrections will be necessary.



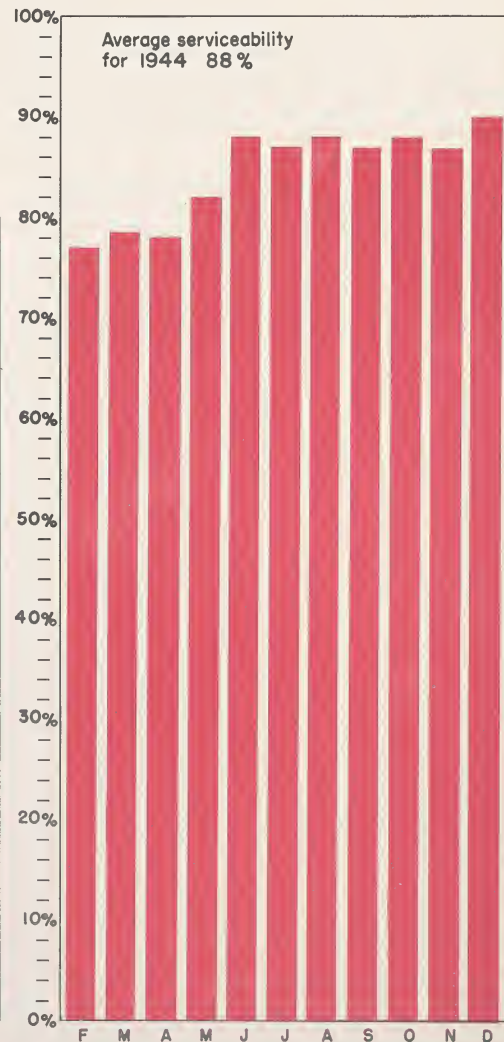
**SORTIES AND EFFECTIVE
SORTIES FLOWN BY H₂X
DURING 1944**



**NUMBER OF BOMBARDMENT
GROUPS EQUIPPED WITH
H₂X DURING 1944**



**% SERVICEABILITY OVER
TARGET OF H₂X DURING 1944**



2. GEE-H

The 28 January 1944 was a cloudy day. B-24s of the 93rd Bombardment Group moved up through the overcast, bound for Bonnières, France. Their targets were flying bomb installations located behind the invasion coast.

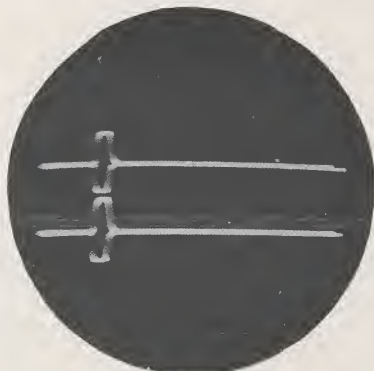
Over the English Channel, navigators on ships with Gee-H airborne equipment flicked on their receivers and transmitters. Immediately the transmitters sent out pulses which "triggered" or actuated all Gee-H ground stations within a range of 200 miles. The answering pulses returned on another frequency to the Gee-H receiver in the plane where they were translated by the cathode ray tube into pips on the scope.

One of the pips represented the distance from the "cat" or range station; the other the distance from the "mouse" or releasing station. First the navigator watched the "cat" pip. Each pilot was holding his B-24 on a course along the arc of a circle cutting the target, and the center of that circle was the location of the "cat" station. If the B-24 got off course the navigator corrected the pilot after checking the "cat" range.

The navigator flicked a switch on his scope. Instantly the position of the "mouse" pip was calibrated in Gee-H units. Beside the navigator were a series of pre-determined check-points computed at Eighth Air Force Headquarters by trained Gee-H experts. These check points were also in Gee-H units. By comparing the calibrations on the scope with the data furnished by higher Headquarters, the navigator checked his progress toward the warning point.

Both the navigator and bombardier knew in advance that after the aircraft reached this final check-point, a timed run would be necessary, at the end of which the bombs would be released. The length of this timed run was a figure in seconds computed by the navigator from "warning period" tables based on the true altitude, ground speed, and type of bomb. This figure was transmitted to the bombardier.

As the B-24 approached the "warning point" the navigator kept his eye on the "mouse" pip. The minute it reached the pre-determined range



GEE-H SCOPE JUST BEFORE "BOMBS AWAY"

"The answering pulses were translated.... by the cathode ray tube into pips on the scope. One of the pips represented the distance from the "cat" or range station; the other the distance from the "mouse" or releasing station".

he called to the bombardier, "Check!" Now the B-24 began its timed run for the target. The bombardier carried a stop watch. At the completion of the timed run, he released the bombs.

Until after D-Day almost all Gee-H missions were attacks on V-weapon sites, usually by small forces led by less than a dozen Gee-H equipped aircraft. From January to June 1944, 31 Gee-H missions were flown.

After D-Day, the scale of Gee-H operations suddenly expanded. Airfields, bridges, marshalling yards, crossbow sites, road junctions, supply depots, etc., were attacked. Between 10 June and 21 June, approximately 3,000 sorties bombed on Gee-H lead aircraft, as many as twenty different targets being attacked simultaneously.

While these summer operations continued, the Operational Analysis Section of Eighth Air Force Headquarters engaged in a study to refine

the "cat and mouse" technique. By mid-September this resulted in a method which synchronized the bombsight at each check-point instead of waiting till the final warning point.

Now before the bombers were airborne, both navigator and bombardier received teletyped data containing a series of check-points, computed to a high degree of precision. The navigator's data was listed in Gee-H units; the bombardier's in corresponding sighting angles. When the navigator calibrated his position at each check-point, he telephoned the bombardier and said, "Check-point 1, check-point 2, etc." Immediately the bombardier checked his corresponding sighting angle and adjusted it into the bombsight. The plane continued along the prescribed course until the bombsight automatically dropped the load.

Gee-H experts at Headquarters computed the course and target data from distances and bearings of the ground stations from selected aiming points. These precise distances and bearings were figured for the Eighth Air Force by the Air Warfare Analysis Service, a British organization specializing in such work. Gee-H equipment was actually a British development for navigation. Experimentation converted it into a bombing aid.

Gee-H operations were resumed in late September 1944 when the British installed ground stations at advanced sites on the Continent, giving coverage beyond the Ruhr. The 2nd Air Division was now using the new synchronized bomb-sight technique, but the 1st Air Division continued with the warning point system.

Both these methods were employed in the first Gee-H large-scale tactical mission against forts in the Metz area on 9 November 1944, which the Army considered very successful. Again Gee-H was profitably employed in tactical bombing at Eschweiler on 16 November 1944, when two of the three areas attacked were assigned to Gee-H.

By December, with the continued expansion of Gee-H bombing, all navigators were trained in the bombsight technique and the warning point system was no longer used.

3. MICRO-H

Due to the nature of the areas to be bombed by overcast methods, target identification difficulties with standard H2X equipment increased. So a technique of overcast bombing was introduced to improve the accuracy of H2X. This improvement was called Micro-H. It applied the "cat and mouse" principle of Gee-H to the H2X scope.

Once airborne, the force navigated by Gee to the Initial Point, about 35 miles from the target. Here the navigator turned on his H2X scope to "beacon". Instantly the scope received pulses from two Micro-H stations transmitting on assigned frequencies from installations near Namur, Belgium, and Verdun, France. The ranges of these stations were represented by two bright white dots, both approximately equi-distant from the center of the scope. If they were not, the navigator corrected the pilot's course accordingly so that the aircraft moved along the Gee-H course toward the start of the bomb run.

As in the case of Gee-H, Micro-H experts at Eighth Air Force Headquarters computed a series of check points for the navigator with corresponding sighting angles for the bombardier. When the aircraft began its bomb run about ten miles from the target the navigator set his first check point on the scope in the form of a range circle. Then as the aircraft moved toward the target the two white dots moved simultaneously toward the circumference of the range circle.

The moment they touched it the navigator warned the bombardier, "Check 1". Immediately the latter synchronized his bombsight to include the corresponding sighting angle. Subsequently, each check-point along the bomb run was synchronized into the bomb-sight until the aircraft reached the release point.

Micro-H operations over Germany began on 1 November 1944 after intensive preliminary work. Radar operators and bombardiers of all three Divisions received a thorough course in training and several practice missions were run in England. Only 3rd Air Division eventually bombed on Micro-H. However, all three Divisions trained because Gee-H, used by 1st and 2nd Divisions, operated on the same frequency range as Gee, which had already been jammed quite successfully by the enemy. Nullification of Gee-H by jamming would have found all three Divisions prepared on Micro-H, which could not be jammed. Fortunately this never happened.

Whereas Gee-H stations were manned by British personnel and portions of the data computed by them, Micro-H was primarily an Eighth Air Force service. Personnel manning the beacon stations came from Alconbury. Targets were pin-pointed by our 325th Photographic Reconnaissance Wing, and computations made entirely by Micro-H experts at Eighth Air Force Headquarters.

The original Micro-H technique had three inherent restrictions - range, target handling capacity, and course. Only ranges within 180 miles of the beacons were feasible, and because of the course, forces could bomb but one target at a time, being limited to two avenues of approach - inbound and outbound. Where flak or wind direction threatened to interfere with the course, Micro-H was impracticable.

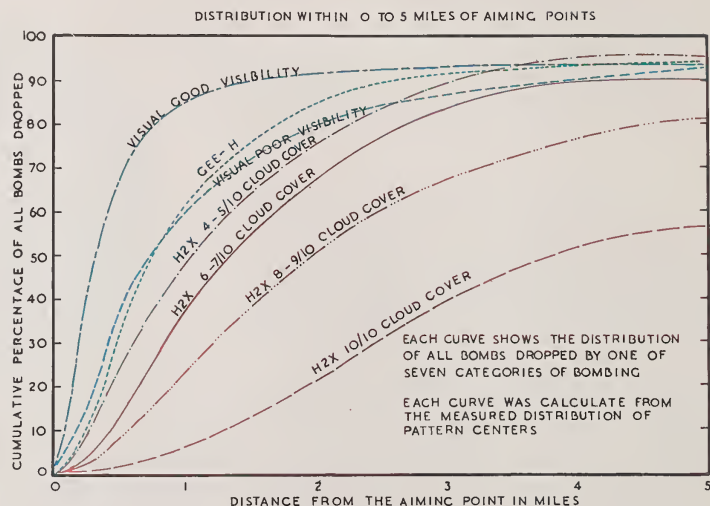
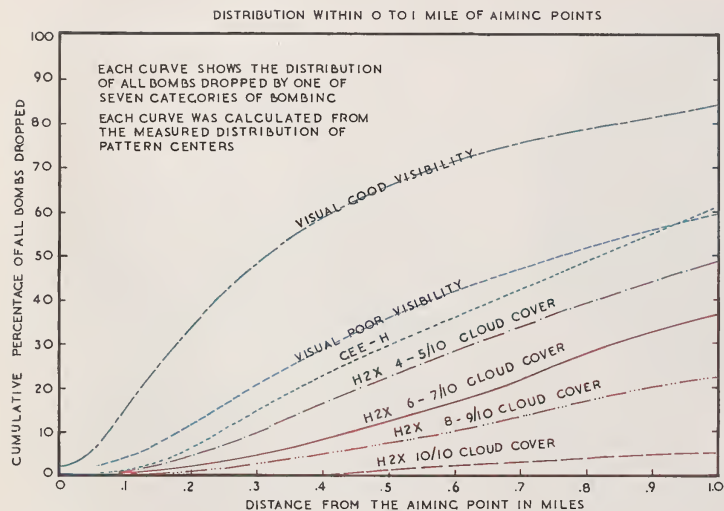
Range limitations continued, but target handling capacity and course restrictions were solved by the introduction of the "cat and mouse" technique used so successfully in Gee-H bombing. Now the two white dots on the H2X scope represented the "cat" or tracking station and the "mouse" or releasing station.

As in Gee-H, four target approaches were possible. Only now any number of targets could be attacked. The beacons were set up so that different "cat" ranges for tracking could be given to each force while using separate "mouse" check points on which to release. This made the whole system more flexible because beacons were no longer tied down with a timed delay calculated for one specific target only.

"Cat and mouse" Micro-H bombing began on 18 December 1944. Most of the 38 attacks by Micro-H employed this more flexible technique which was enhanced by the installation of another beacon at Nijmegen in January 1945.

VISUAL AND OVERCAST BOMBING PERCENTAGE DISTRIBUTION OF EIGHTH AIR FORCE BOMBS

1 SEPTEMBER 1944 — 31 DECEMBER 1944 (EXCLUSIVE OF THREE ATTACKS IN CLOSE COORDINATION WITH GROUND FORCES)



4. COMPARISON OF BOMBING ACCURACY FOR H2X, GEE-H, MICRO-H AND VISUAL BOMBING.

While the above charts compare the accuracy attained when bombing visually with bombing by instruments, this is not really a fair comparison. Bombing through the overcast is not an alternative method to visual bombing. It represents a direct addition to capability by permitting bombing when visual sighting is impossible.

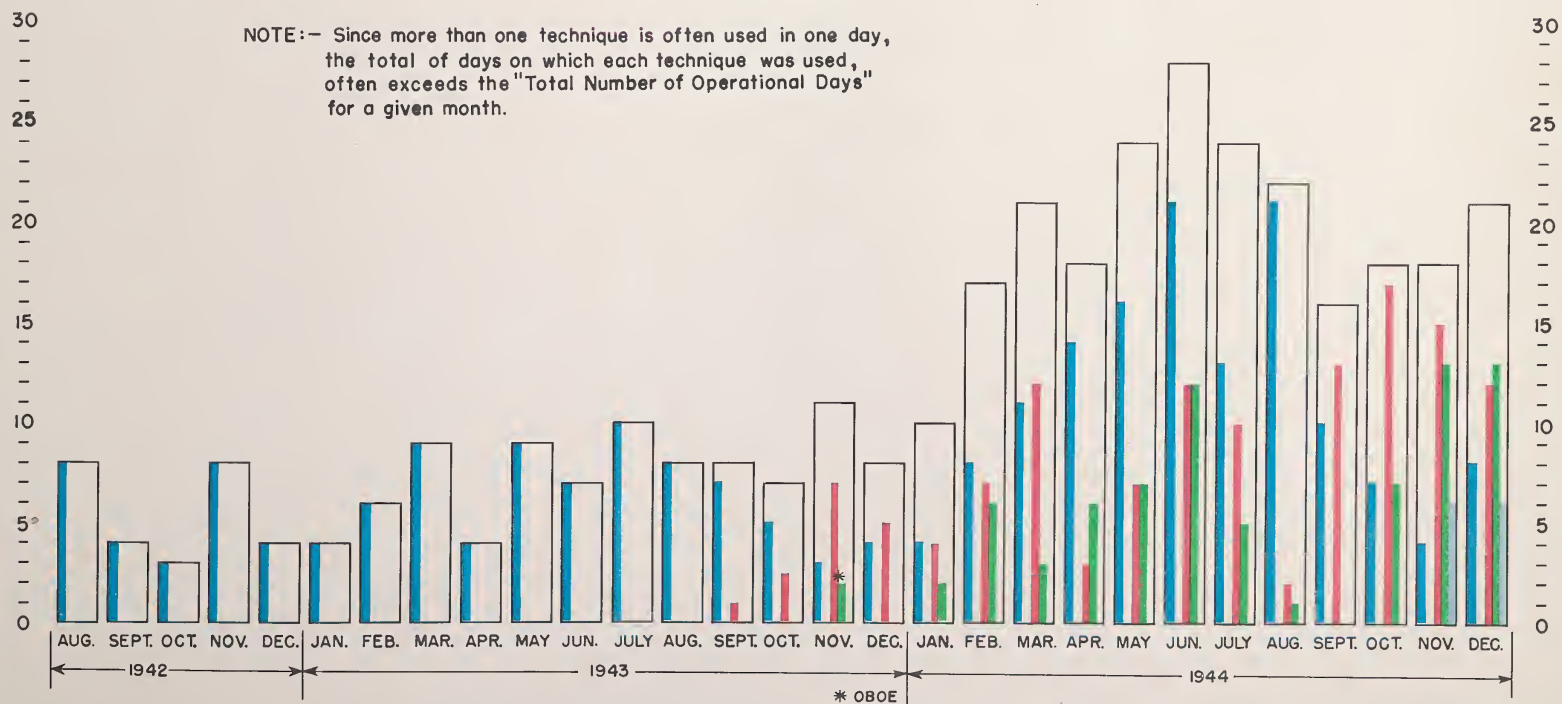
H2X is a valuable means of bombing specially selected large area targets which can be located by the H2X radar scope. It is also of great value in correcting navigation on partially overcast days so that the bombing force may line up correctly for a visual run.

Gee-H and Micro-H permit reasonably accurate bombing of pin-point targets within their range when the more accurate visual sighting cannot be used.

All types of overcast bombing made possible additional visual bombing since the forces would go out prepared to bomb either way should the target be cloud-covered. If the clouds would clear briefly, a visual run would be made.

CHART SHOWING, BY MONTHS, THE NUMBER OF DAYS ON WHICH TARGETS WERE ATTACKED BY EIGHTH AIR FORCE HEAVY BOMBERS

- (A) VISUALLY - ■
- (B) BY H₂X - ■
- (C) BY GEE H - ■
- (D) BY MICRO H - ■



CHAPTER IV

TARGETS

TARGETS

America's air strategy in the European Theater was two-fold: it was, first, to defeat the German Air Force, and then "to weaken the German military, economic and industrial capacity to wage war" in preparation for a ground invasion. To prepare for invasion, Germany's war capability had to be reduced to the level of our calculated capability for invasion. The prime condition needed was that Allied airpower must be able to dominate the skies above the assault area.

The invasion was accomplished without any serious attempt at air opposition. The beach-head was exploited, and the enemy was driven back to the Siegfried Line within six months. Germany's armed resistance was entirely crushed within ten months after D-Day.

What part did bombing by the Eighth Air Force play in this rapid defeat of the mighty German Army? What targets were bombed, and why were they selected?

The Anti-Submarine Campaign.

Chronologically, the first major target assignment of the then diminutive Eighth Bomber Command was to attack submarine bases and submarine building facilities. It was realized that the results to be expected from the small force of bombers could not be great. But German submarines were making a very serious threat to close Britain's supply lines from America. If these lines were interdicted, not only would Britain be in a serious position for food and supplies, but also the planned build-up of American strength at British bases would be halted.

The situation had become critical by the fall of 1942. Every available means was marshalled to halt the submarine threat. The Eighth Air Force received a new priority: essentially it was to join in defending the security of supply lines, particularly those to the United Kingdom.

Targets assigned were, first, five submarine bases on the Bay of Biscay, and later, submarine construction yards on the North Sea coast of Germany.

A series of attacks was made in the fall, winter and spring of 1942-1943. Considerable damage was done to the submarine yards,

especially at Vegesack, near Bremen. Also, where locks were required to hold tidal water up to an operating level for submarine bases in Western France, these locks were destroyed. Such submarine bases were put out of effective use during an important period in the anti-submarine war. But the pens, or submarine bases themselves were protected by such a thick cover of reinforced concrete that they provided a very low order of vulnerability to the bombs then available.

Eighth Air Force attacks against the submarine considerably hampered the refitting of U-boats. A profitable contribution was made, thereby, to the defeat of the submarine menace, while concurrently developing tactics and technique for future full-scale air operations against Germany's war structure.

The Defeat of the German Air Force

The next major target assignment was to defeat the Luftwaffe. This became the primary effort of the Eighth Air Force from June 1943 until April 1944. The target systems chosen for attack were:

- (1) German fighter assembly plants;
- (2) Airframe component plants (where they could be found)
- (3) Ball bearings;
- (4) Enemy fighters, in the air and on the ground.

Airframe assembly plants were chosen for the major target system for bombing because, to begin with, production was concentrated largely in eight main plants which, it was estimated, would soon be within our capability to attack. Also, it was felt that the results of such attacks would be felt more quickly than would attacks on aero engine factories.

Component plants were realized to be better as targets because the effect would be more lasting than would the destruction of the simple structures used for assembly. But component plants were much more numerous and dispersed in city areas where they were hard to locate in the bomb sights. They were to be hit wherever possible.

Ball bearings were believed to be an excellent target system, the plants being hard to replace, and being vital to the production of many weapons and vehicles as well as aircraft. Also, the great plant at Schweinfurt represented a concentration of 38 percent of Germany's existing productive capacity.

The enemy fighter force included one item which would be virtually impossible for the enemy to replace within the limited time before invasion was scheduled - experienced pilots. Aircraft can be produced in a matter of weeks but a pilot requires a year and a half for adequate training. Also the supply of high-grade pilot material was limited, and battle experience was lost when a veteran was replaced by a trainee. Hence attacks on fighters in the air were far more valuable than on aircraft on the ground.

The new target priorities were the important factor in extending the demonstrated range of our bombers in the summer of 1943. Where our previous deepest penetration of enemy territory had been approximately 160 miles, we now rapidly pushed out to a penetration of over 300 miles. Our fighter escort, however, were not yet capable of anything like this penetration. Hence the bombers were required to fly far beyond the range of escort to reach aircraft factories or ball bearings.

Since our spring attacks on Northwest Germany, the enemy had strongly increased his dispositions of aircraft on the Western Front and had begun to arm them much more heavily. Our few attacks in 1943 on aircraft and ball bearing plants being well beyond escort range, resulted in very heavy losses. It was apparent that growth of the bomber force would not suffice to permit the continuation of attacks on these targets in the face of the demonstrated capability of the enemy to inflict serious losses. A new factor was needed in our attack.

The new factor made a timely appearance in the winter of 1943-1944 in the form of long-range escort. By February, the force of long-range escort had reached a size which seemed big enough to attempt an attack on the vital aircraft plants in the Leipzig area. With considerable evasion planned in the route, as an aid to our escorting force, the bombers attacked a series of important targets. This first day's attacks marked a turning point in

TARGETS

the air war. For the aircraft plant destruction was sufficient and our fighter's destruction of enemy aircraft so large, that the winning of the air war now came within our capability.

Beginning in March the Eighth Air Force discontinued efforts to evade enemy fighters in its operations. To accomplish our mission, we must not only bomb the aircraft factories, but also force enemy fighters into the air. We now sought to provoke enemy fighter reaction. And our escort fighters proceeded to take heavy toll, preventing the increased attack from crippling our bomber force. The bombers added substantially to the number of enemy fighters accounted for. Dominance of the air was in sight.

April brought new commitments to the Eighth Air Force. Specific targets must be hit to prepare for D-Day. Though enemy fighter aircraft assembly had been effectively hit these plants could be rebuilt or dispersed in two to four months. The new commitments prevented the continuance of attacks which might have held aircraft production down.

But the war in the air was already won. The enemy had lost two irreplaceable commodities. His supply of experienced fighter pilots was depleted. And some months of reduced aircraft production during a crucial period could never be replaced. Now if he built aircraft he would have only inferior pilots to fly them. Had he had full aircraft production while his pilot force was strong, the winning of the war in the air might have been greatly protracted.

During the latter months of this target program, aircraft pools and repair depots were attacked whenever possible when weather prevented attacks on targets of higher priority. But ball bearing plants, hit with some success in the summer and fall of 1943, were left to a later date. The priorities placed by the top echelon engaged our full effort elsewhere until after D-Day.

Now the enemy was resorting to widespread dispersal of his aircraft plants. Many were placed underground. His new jet-propelled aircraft began to appear and there were rumors of impending huge production of this potentially dangerous weapon. Though dispersion of plants and the development of underground factories

greatly diminished the vulnerability of the jet complex as a target system, the seriousness of the threat caused jet production to be put on a high priority in the fall of 1944. It retained this priority until the end of the war. And though aircraft now were produced in ever increasing numbers, the decline in the number of our bombers lost attest to the fact that the fighting capabilities of the Luftwaffe were rapidly declining. This is further underlined by the great number of the enemy which our fighters now destroyed.

All target systems have ramifications into other fields. Our new priority just before and after D-Day was oil. Though the Luftwaffe was strongly on the decline before we began the oil offensive in Germany, oil shortages soon began to multiply the effects of the earlier attacks on aircraft plants and pilot experience level. Fuel shortages now began to curtail training programs, and diminished training intensified the trend of the dropping experience level.

A further dividend of the aircraft factory attacks appeared. The products of the underground and dispersed factories were definitely of inferior workmanship and mechanical reliability. Non-combat losses of aircraft and pilots mounted steeply. This further harassed

the beleaguered Luftwaffe. Lack of combat success added home criticism to its woes.

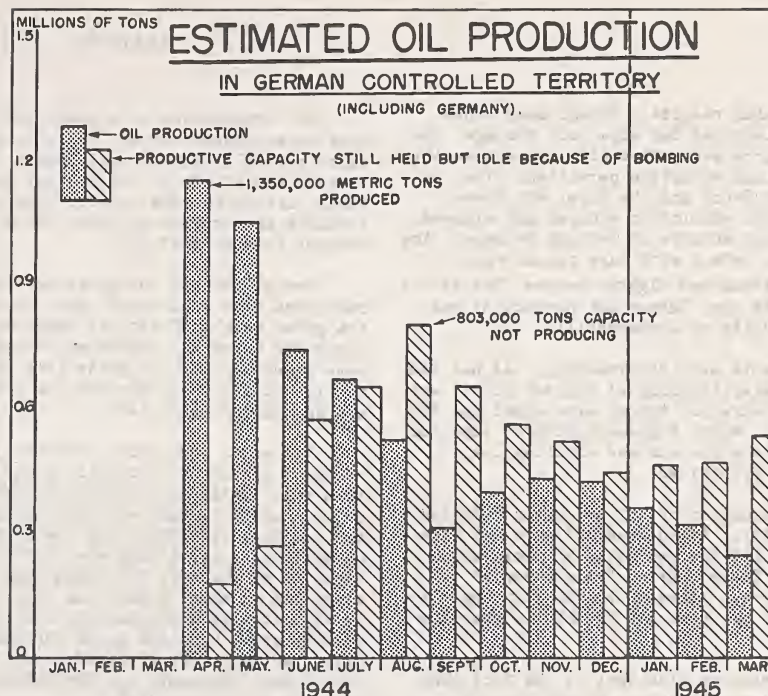
Toward the end of the war, the Luftwaffe ceased to be a factor to be reckoned with.

Oil

The great attack on the Leipzig area on 20 February, 1944 had an important collateral effect. For it demonstrated that the time was near when the great synthetic oil refineries of Germany would be within our bombing range.

It had been held that oil could not become a major target system for the Eighth Air Force until the great aggregation of refineries at Ploesti, Rumania had been seriously crippled. A low-level attack on 1 August, 1943, and subsequent attacks by the Fifteenth Air Force, had crippled Ploesti's capacity to a satisfactory degree. Now the Eighth Air Force was indicating a capability of penetration in depth necessary to attack all the vital synthetic oil producers.

The Eighth Air Force attacks on oil began in mid-May, 1944. The ground invasion, beginning soon thereafter, prevented continuous attack on this target system for some weeks. But in September 1944, a series of attacks began which



TARGETS

had far-reaching results. Though many other commitments involved far more bomb tonnage, the Eighth Air Force went after oil whenever weather and the tactical situation permitted. The Fifteenth Air Force and the Royal Air Force joined in. Oil production slumped and slumped, despite frantic efforts of Germany to repair the damage and to defend with huge concentrations of flak batteries and fighter masses. But before the end of the war, German oil production was brought virtually to a standstill.

The effects were far-reaching. As has been indicated above, training of fighter pilots was curtailed. Tanks and trucks were abandoned for lack of fuel. Motor transportation of supplies was reduced to a minimum and civilian use of gasoline was prohibited.

The destruction of oil seriously crippled German mobility. "Requirements" were cut time and again to fit the realities of diminished production. These lowered "requirements" represented a great decrease in military capability. The end was apparent to all who knew the facts.

An interesting sidelight is the fact that Field Marshal von Rundstedt placed the oil offensive only second to our air supremacy as a cause of Germany's defeat.

Transportation

The transportation system in Occupied Countries and, later, in Germany received varying proportions of our bombs throughout the war. Marshalling yards were among our earliest targets. Around D-Day, they received a gigantic effort from the Royal Air Force as well as the Eighth and Ninth Air Forces. Transportation targets, of one type or another, occupied more of our effort than any other target system.

The reason for this is obvious. If Germany's transportation could be interdicted, her whole ability to wage war would disappear. Modern wars are known to have many men making supplies and munitions for every man on the firing line. The mine worker, the factory hand, the train crew, and the soldier are an integrated team, - all contributing directly to the firing line. Without transportation, coal and iron cannot reach the factory, nor can the munitions and supplies reach the soldier. Such a situation would deprive the Army of its weapons, and without weapons a modern army loses all military value.

Clearly transportation was a target system of the utmost importance.

Our transportation attacks can be seen to have three phases: first, the attacks on the major marshalling yards and repair facilities; second, the attack on the smaller marshalling yards; and third, the interdiction of rail lines, viaducts and bridges by which all movement was brought to a standstill.

The attacks on the great marshalling yards persisted over a period of many months. However, the great weight of attacks began with preparations for D-Day and continued as long as there were great marshalling yards left to attack in the tactical area or between the tactical area and manufacturing centers.

There has been much controversy about the value of attacks on marshalling yards. It is true that, after most bombing attacks, a line or two can be re-laid so that through traffic can continue its trip. But the great points of value about such attacks are, first, that the capacity of the yard to handle huge tonnages on which the adjacent industrial facilities depend is violently reduced; second, much valuable rolling stock (and the goods contained) are destroyed; and, third, round houses and repair facilities frequently are destroyed, thus creating a vicious circle.

There can be little doubt that the destruction of the great marshalling yards seriously disrupted Germany's war production.

The second phase was brief in duration but may have had a very important effect in bringing the war quickly to a close. In this phase, the German Air Force was so reduced in its capabilities of defense, that the bomber force, carefully screened from attack by our fighters, was able to break down into small units and attack a large number of small marshalling yards, junctions and intersections in a band north and south across Germany. Since the Royal Air Force and the Ninth Air Force joined in, each air force taking a prescribed area, virtually the entire rail system of Germany was cut in two days. Repair trains and equipment were far inadequate to cope with any such catastrophe in time to save the flow of industrial production.

Thereafter, similar exploitation attacks were continued against the transportation system until the end of the war. These attacks effectively paralyzed, not only his transportation system, but his whole war economy. A third type of operation was attacks primarily for interdiction. These were directed at cutting rail lines, bridges and viaducts as a continuing

program. More effort of this type was expended by the Ninth Air Force since this was truly a tactical operation. But the Eighth Air Force joined in these attacks when weather and the situation permitted, just as the Ninth Air Force joined in the strategic operation of bombing the band of small marshalling yards.

Miscellaneous Targets

The target categories, miscellaneous in character, were sufficiently important to mention. They were armored vehicle factories, motor vehicle factories and ordnance plants, etc.

All three were tactical in their importance and in the timing of the attacks. Whenever it was discovered that some plant was feeding important quantities to the front lines in support of their ground battle, a mission was flown, weather permitting, to destroy that plant.

Overall Effect on Manpower

Strategic bombing forced the enemy to commit a huge portion of his manpower and military resources to oppose these air invasions - thereby seriously reducing his ground force strength and capabilities. The major commitments were first the German Air Force, including pilots, mechanics, supply and repair forces; second, the Air Raid Warning Services, including a great network of observers, a chain of radar technicians the whole length of the European coast, filter and control room personnel; third, flak battery personnel, for the thousands of flak guns over Europe, smoke screening and camouflage personnel. A secondary group was the huge number estimated employed to repair bomb damage, the estimates ranging from 500,000 to 700,000.

A more difficult group to evaluate is the enormous number of people employed, wholly or in part, in producing the machines, munitions and supplies required by all the personnel of the German Air Force, the flak batteries and the watching services. It would be rash to hazard a guess, but that it comprised an important percentage of Germany's manpower, there can be no doubt. Even more important is the fact that all three categories, the German Air Force, the flak batteries, and the warning services, require personnel much above average intelligence and skill, thus involving a qualitative drain even more costly than the great quantitative drain would indicate.

TARGETS

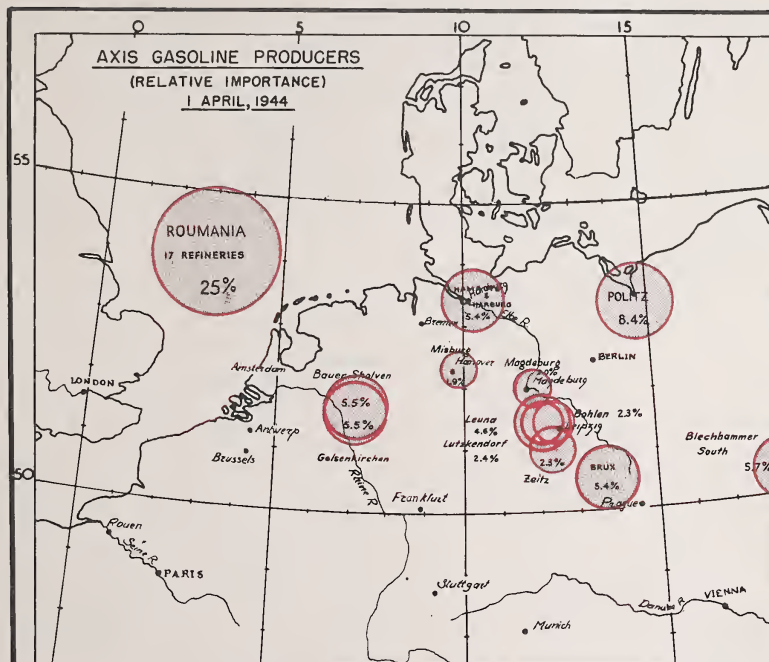


Chart A.

The relative importance of gasoline production in the various German controlled areas of central Europe is shown in the above chart.

The percentage of the total which was produced at the 17 refineries of the great Ploesti area in Rumania was so great that a crippling of Ploesti was considered essential before starting a general attack on oil.

The importance of the refineries at Politz was greater than indicated by production. The reason for this was the fact that Politz produced a high percentage of the total of aviation gasoline.

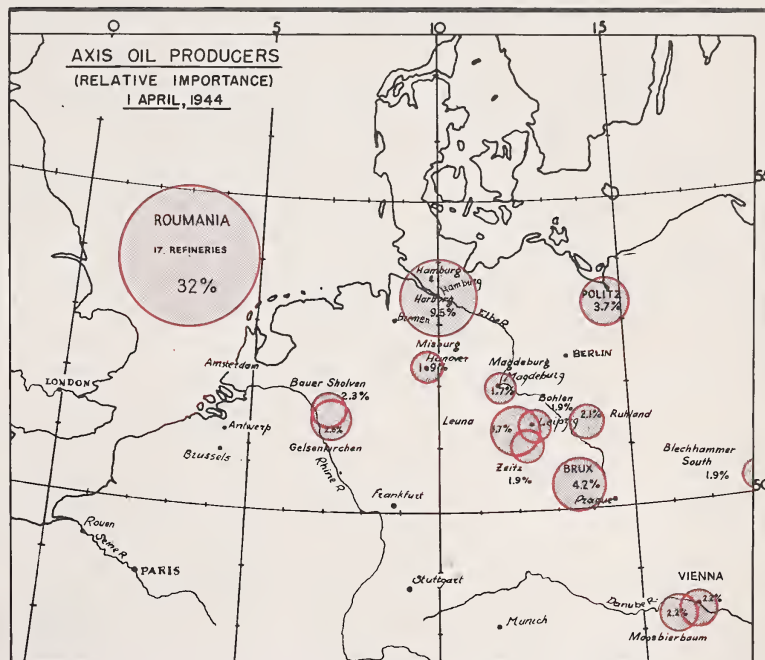


Chart B.

The huge production of oil at the Ploesti refineries dominated the oil target situation.

Oil production in Germany was divided into two categories: refining of crude oil, and synthetic production.

The great areas of crude oil refining were around Hamburg, Hanover, and the Ruhr.

Synthetic oil production centered around the area of Magdeburg-Leipzig-Dresden, with a very important plant at Politz near Stettin.

TARGETS

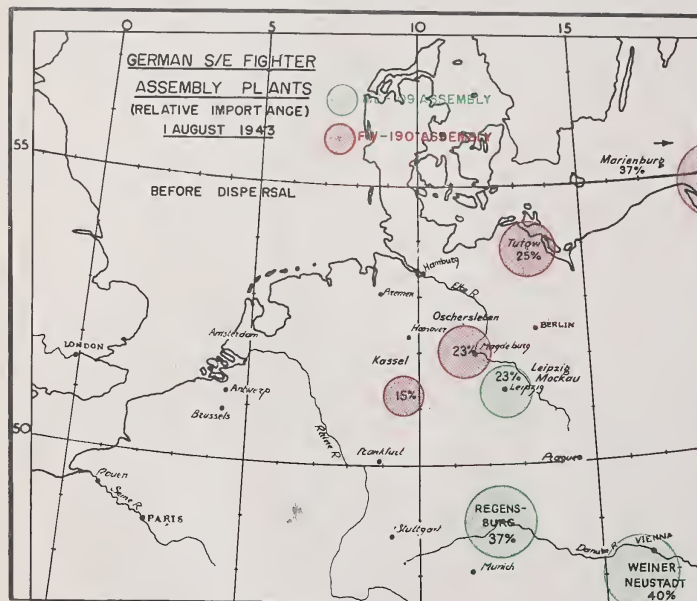


Chart A

Early in the war German single-engine fighter assembly was centered around a few great mass production plants. These areas are shown above in proportion to their relative importance.

The two dominant single-engine fighter types were the Me-109 and the Fw-190. The production of each assembly plant is given as a percentage of the total production for the type produced.

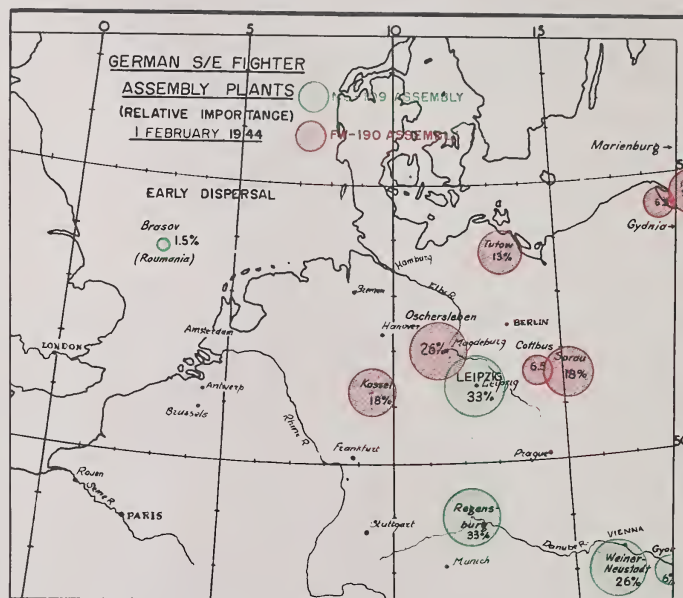


Chart B

Before the great attack on aircraft assembly plants begun 20 February 1944, a start had been made at dispersal of facilities. This had changed the situation relatively little. But the all-out attack begun in February forced an increased tempo of dispersal of the entire industry.

TARGETS

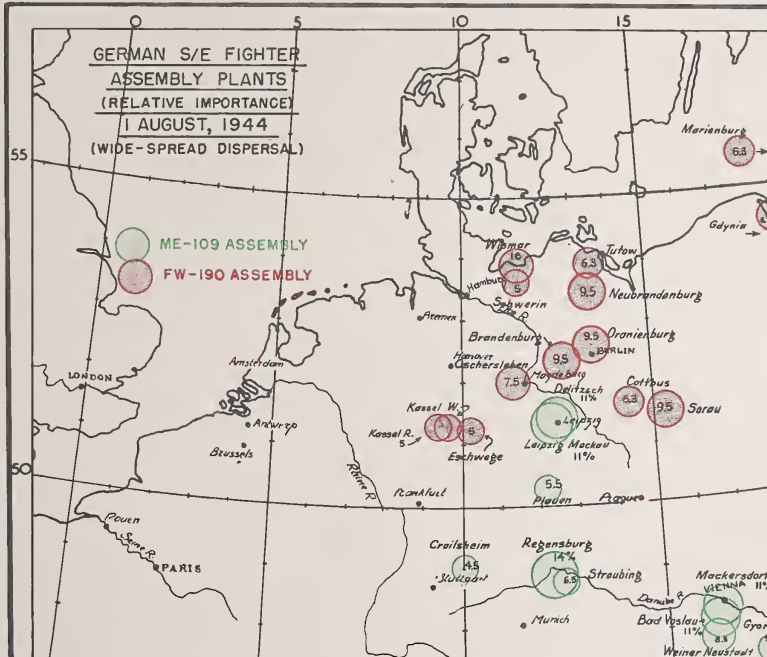


Chart A

When dispersal of aircraft production facilities had advanced to the point indicated above, the industry then was exceedingly vulnerable to attacks on transportation. Such attacks disrupted deliveries of components and parts.

Planned production was impeded during the vital race to build up the German air forces. Once Germany lost ground in this race, the enemy never was able to recover his lost position.

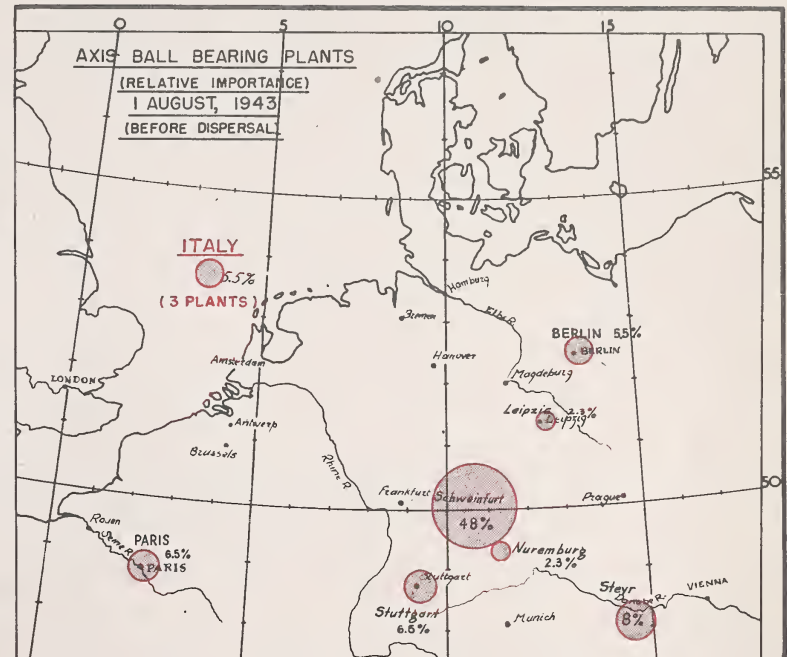


Chart B

Schweinfurt dominated the production of ball bearings for the Axis. Its importance as a target was well recognized even before the war began.

Early attempts to destroy Schweinfurt met with partial success. When long-range fighter escort was available to permit full-scale attack, Schweinfurt's importance had been reduced by the fact that the enemy had developed substitute bearings in the interim.

CHAPTER V
THE AIR WAR ON THE WESTERN FRONT
1942-1945

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THE AIR WAR ON THE WESTERN FRONT 1942 -1945

I. INTRODUCTION — SETTING THE STAGE FOR THE EIGHTH AIR FORCE

The Conception of the Eighth Air Force

When, on 17 August 1942 with twelve B-17s and a covering cloud of Royal Air Force Spitfires, the Eighth Air Force made its first attack on "Fortress Europe" it translated into action years of military planning. American military experts had developed an air theory from conceptions of the use of air power proounded by Douhet, Mitchell, and many others. Predicated on this theory, production and training programs were in operation for building the most powerful air force which modern warfare had yet seen, after years of peacetime testing during which aircraft were designed and redesigned.

How was this air weapon to be used? Proponents on one hand saw the airplane, not as a limited weapon, but as a means in itself of winning a war. Through it, firepower would gain a range and mobility which they believed would be decisive in warfare. On the other hand, the ground services felt that air power must prove itself in practice before it could be relied upon to deliver the blow resulting directly in defeat of the enemy.

By compromise, the American plan to utilize air power was limited in its objective. The plan was: to gain clear air supremacy over the enemy, and then to cripple his military, economic and industrial capacity to wage war to the point where his ground army, well-equipped and trained, could be beaten on its "home field" by Allied ground forces necessarily limited in both training and battle experience.

The United States entered the war with an ally having experience and a base for operations, both invaluable to the rapid exploitation of the American plan. The range of America's existing and planned aircraft equipment made British bases vital. Experience and data accumulated by the British in their war for survival aided greatly during this experimental stage.

British bases, however, did not adjoin primary objectives. The Eighth Air Force could come to grips with the enemy just across the English Channel or the North Sea. But in these enemy-occupied countries (France, Belgium,

Holland, and Denmark), there were civilian populations which it was hoped could be liberated from the Nazis with minimum loss to them. Hence, bombing there must be limited. Further, war production in occupied countries was very small compared to production in the Reich. The main target area began 250 miles east of London and extended another 400 miles beyond, ranging northward from Switzerland to the borders of Denmark. However, the real vitals of the Reich were the Leipzig-Berlin-Hanover area and the Ruhr. Between these vitals and bases of the Eighth Air Force in Britain was the Luftwaffe, based in occupied countries to intercept attacks against Germany's inner core.

Hitler's Concept of Air Power

What was the doctrine behind the Luftwaffe's defensive strategy? Lindbergh had asserted that Germany had a powerful air force, and subsequent conquests in Poland and France had proved him correct. Why, then, was such a weapon used in an almost purely defensive role? Simply because air implementation of ground attack was the concept adopted by the German High Command when organizing this air force. The enemy saw an air force as a weapon primarily for use in obtaining decisive results in ground battle. His policy makers did not envision that the decisive battle itself might take place in the air. This lack of imagination had far-reaching results: it was the flaw in Hitler's plan of conquest, for it lost him the Battle of Britain.

On 4 September 1940, Hitler threatened to wipe out the major cities of Britain if that nation continued to defy him. This actually meant putting the German Air Force to work on a strategic assignment involving large-scale dislocation of the British war economy, for which it was unprepared. Almost immediately the German Air Force launched a daylight air offensive from a multitude of nearby French bases. Everything seemed to favor its success. Britain appeared unequal to the task of defending a highly vulnerable concentration of targets against German air power, disposed at short range in bases affording innumerable lines of attack. But the Luftwaffe had not been designed for this task. Bombers which were effective ten miles behind a battle line were entirely inadequate to attack successfully huge industrial

areas. Although greatly outnumbering the Royal Air Force, German fighters failed to achieve aerial supremacy over the British Isles. They were neither equipped nor trained to match the tactics of the very numerically inferior adversary. Here was a decisive air battle which Hitler had not foreseen. In order to continue the Battle of Britain, the Luftwaffe was forced to resort to night bombing. This constituted Hitler's first real set-back and it was of tremendous importance. But instead of re-evaluating the requirements of air warfare, Hitler seems to have said to himself, "If I can't destroy the enemy's war economy from the air, then no one can destroy mine". From that date the German mind, which had ridiculed the Maginot concept on the ground, now embraced it in the air.

Henceforth, German air power was to be defensive.

By this change in attitude toward air, Hitler indicated a new limit to his objectives: for an indefinite period he would be content to isolate "Fortress England" while he set his own "Fortress Europe" in order, particularly in the east. His plan was to make Europe secure from water-borne attacks from the west through maintenance of an unbeaten army and a powerful defensive air force based mainly in France and the other conquered buffer states. Henceforth, the Luftwaffe was charged, in addition to its "normal" role of ground support — with the defense against any air attacks which the British might attempt. Even later, when American plans for a huge offensive air force became known to him, Hitler's erroneous evaluation of the threat implied prevented preparation of an adequate defense. Instead, the Fuehrer dreamed of weapons of the future to encompass the east defeat of Britain without invasion by sea or by air, but rather by submarine blockade and by long-range projectiles such as the "buzz bomb" and the V-2 rocket weapon.

British Air Plans

Britain meanwhile was busy developing a far different air strategy. Too weak unaided

(CONTINUED ON PAGE 85)

I. SETTING THE STAGE FOR THE EIGHTH AIR FORCE

to carry out the appalling task of water - invasion of Europe, Britain turned to the air weapon as a prime means of defeating Germany. Failure of the German Air Force with its predominance of medium bombers to effect vitally the war economy of Britain, and the long expressed American confidence in the four-engined bomber, certainly influenced Britain to begin mass production of this type of aircraft. The British concept of air war was bold, but it missed part of the lesson already taught to the Germans by the Royal Air Force, for the British attempted to use heavily loaded four-engined bombers for low-level daylight attack deep into enemy territory without adequate defense for the bombers. The first raid to Augsburg, 4 April 1942, met with such disaster that the British decided to turn at once to night attacks, in which enemy interception was less efficient, but in which also bombing of precise targets became much more difficult.

The American View of Air Warfare

America, then, had two test cases to study as to the practicability of daylight air bombardment of enemy industry: first, the German and then, the British. Both cases indicated that daylight bombardment deep into the air defenses of the enemy's country was too costly for sustained operations. Both nations had resorted to protective darkness to hinder enemy defenses in spite of the fact that darkness also

impedes accuracy of target identification and bombing. Both fell back on Douhet's theory that a nation's morale could be broken by continuous air bombardment. Each hoped at various times to mount a scale of effort which would bring about this result.

America, however, was not convinced by these two demonstrations that daylight bombardment was impracticable. Leaders of the Army Air Forces felt that neither Germany nor Britain had provided sufficiently for the defense of the daylight striking force. America's first law of tactics was economy of force. This meant the continuous attack on vital objectives made possible by security of the striking force against destruction by the enemy. Defensive measures to obtain security were, (1) the ultimate defense of the bombers by a previously unheard of volume of armament; and (2) mobile and flexible firepower in the form of fighter escort. In this latter factor, America was to break new ground. Generally held beliefs were that fighters were incapable of long-range flight; and that a shorter range fighter, due to its lighter weight, could out-manuever and out-fight a longer range fighter. America brushed dogma aside and studied all the factors. The result? Fighters of a range equal to that of the four-engined bomber and therefore capable of providing escort throughout any mission were developed and used successfully. These fighters were also engaged in all types

of cooperation and carried out a considerable number of independent missions.

So the stage was set: Germany, beaten in the Battle of Britain, had gone on the air defensive, certain that "Fortress Europe" strengthened by an unbeaten army garrison would be secure. Britain, equally secure in geographical defense, but without a comparable army, had embarked on an air offensive applied at night. America would now begin to test the following theories: that the best policy for winning the air war is to meet the enemy at every opportunity and destroy him in the air; that the final collapse of Germany would take place after that nation's war potential had been reduced by bombing to a point where Allied ground forces could cross the great barrier of the English Channel and defeat the battle-hardened German armies in the west. It is worth noting that Hitler, with a victorious army, had judged the same channel crossing operation too formidable though faced with what he thought was only weak air and ground opposition in England at the time.

The first step to conquer Germany was to be the subjugation of the Luftwaffe; the second was to be the daylight bombardment of Germany's military, economic and industrial capacity to wage war.

2. CERTAIN FACTORS AFFECTING TARGETS

There were several factors having a general effect on selection of targets for Eighth Air Force attack - weather, flak, and radar and radio.

Weather

Weather in England and Western Europe is bad for flying. Over England, France and Germany, all through the year, there is a procession of storms, frequent fogs and low hanging clouds. Every three days on the average during the winter, a severe storm will be found in the area between London and Berlin. There will be early morning fog approximately twice a week. During the winter, cloud cover over Germany averages 80-90 percent, and even in summer the

coverage averages 50-80 percent. Conditions causing icing and condensation trails virtually always are present but vary in severity with seasonal and air mass changes.

Weather experts of the Army Air Forces had estimated that days suitable for daylight bombing operations in the theater would amount to a maximum of 10 monthly with an expectancy of 6 throughout the year.

Weather conditions turned out to be just as bad as expected; but before the end of the war, the Eighth Air Force actually was flying an average of 22 days a month out of a forecast of 24 operational days. How was this startling change accomplished?

The Problem: Obviously it was necessary to have as high a rate of operations as possible in order to make repeat attacks to prevent Germany from repairing damage caused by bombing. Every effort was made to study European weather and to devise methods for increasing the Eighth Air Force's rate of operations.

The problem was complicated. There were serious difficulties in forecasting such variable weather. There was an additional difficulty of making forecasts of a type with which meteorologists never before had been required to deal on a large scale. For instance, accurate forecasts were required for high-level

(CONTINUED ON PAGE 86)

2. CERTAIN FACTORS AFFECTING TARGETS

winds and over large areas. It was necessary to know also the base and top of all layers of low, medium and high cloud to facilitate the prediction of route and assembly weather. The time of arrival in the base area of major storm systems had to be estimated. It was vital to know ceiling and visibility for landing at base areas.

Early in the war there were standard minimum operational limits. Bombers did not attempt to take off when visibility was less than half a mile and ceiling less than 500 feet. Assembly of the bomber force required several thousand feet of clear weather at operational altitude. Formation flying was not undertaken along routes which would be obstructed by high cloud tops. The Eighth's first few bombing missions required conditions of no more than 5/10ths cloud below 20,000 feet for visual attack on the targets, and landing requirements were a mile of visibility and 1,000 foot ceiling.

It was necessary to have accurate forecasts of conditions for take-off, assembly, route, target and landing so that the bomber force would not be endangered.

The required combination of weather conditions occurred so infrequently that it became difficult to maintain pressure against the enemy. Because of the fallibility of forecasting under war conditions the suitable days were not known always in advance and hence could not be utilized.

The Solution: During the period of the Eighth Air Force's participation in the war, solutions were found for a great many of these weather problems. In general, the solutions resulted from the development of new techniques of weather scouting, navigation and overcast bombing, and from increased experience. Late in the war the availability of alternate assembly and landing areas in France acted to increase the rate of operations.

In order to facilitate the forecasting of route and assembly weather before a mission,

aircraft of special weather reconnaissance units were dispatched to observe cloud layers. To supplement reports from ships at sea and land weather stations and also reports from Royal Air Force weather reconnaissance aircraft, the 652 Bombardment Squadron flew regularly scheduled flights in all types of weather into the North Atlantic as far as the Azores. Fast Mosquitos went far into enemy territory to note conditions over routes and target areas. During the actual missions, P-51 weather scouts flew reconnaissance on weather and reported results. All this greatly improved the accuracy of forecasts and the Eighth's capacity of utilizing weather conditions to a maximum.

In planning a mission the weather map forecast was an important factor in selection of the target. Altitude and routes were chosen to a considerable extent to be where cloud and condensation trails were at a minimum. The direction of attack was governed largely by the wind forecast at bombing altitudes over the target. The zero hour was chosen primarily to obtain minimum cloud over the target. All these factors had to be geared to conditions at base suitable for take-off and landing.

Multiple plans for a mission were frequent, with final decision delayed until arrival of the latest weather information. Sometimes this final decision would not be made until the Eighth was over enemy territory. Even then orders for the bombers might be changed on recommendations of P-51 weather scouts, and for the fighters on recommendations of the Micro-wave Early Warning control station. Ultimately a point was reached where a task force could be assigned a number of targets of equal priority in a general area having variable cloud conditions. Arriving before the bombers in the area, P-51 weather scouts would advise the task force commander where weather was best and which targets to attack.

New and improved types of navigational equipment increased the capacity of the force to navigate to distant targets over full cloud cover. Modifications of this equipment, and techniques to utilize it specifically for bomb-

ing, were developed to the point where bombing through 10/10ths cloud became commonplace. Such equipment for navigation included H2X, Gee-H and Micro-H. The same devices used with new and specially adapted techniques, were used for overcast bombing.

The Result: The following table gives an indication of how much progress was made in conquering weather:

<u>Actual Days of Operation</u>				
	1942	1943	1944	1945
January		4	11	21
February		5	18	20
March		9	23	26
April		4	21	
May		9	25	
June		7	28	
July		10	27	
August	7	8	23	
September	3	11	20	
October	3	7	18	
November	8	11	18	
December	4	10	21	

With pressure great to increase the rate of operations, the number of aircraft recalled or aborting due to weather amounted to only 10 percent of total aircraft dispatched by the Eighth Air Force throughout the war. During the last 8 months of operations, September 1944 through April 1945, when approximately half of the total sorties flown were deep into Germany, the rate of abortives had been reduced to 5.8 percent of sorties for a period in which the rate of operations had more than doubled.

It is noteworthy that during June 1944, the crucial invasion month, the Eighth Air Force operated 28 out of the 30 days. Achievement of this was made possible, in part, by charging each individual group commander to train his force and test its capability for flying in bad weather with a view to improvement. Competition between groups to operate a maximum, led to ultimate utilization of virtually every day in the month.

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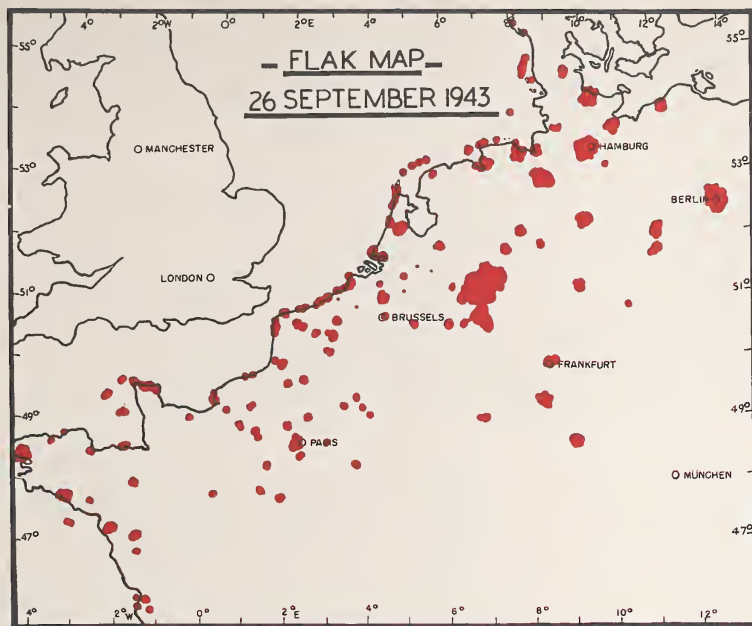


Chart A

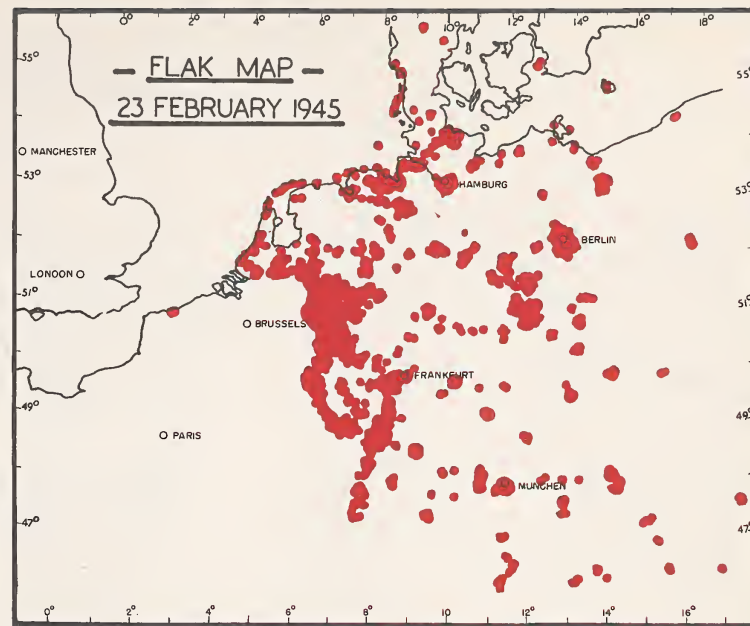


Chart B

2. CERTAIN FACTORS AFFECTING TARGETS

Flak

The Importance of Flak: Flak was a major and ever-present problem throughout the war in Europe. The number of Eighth Air Force bombers damaged by flak always exceeded those damaged by enemy aircraft. However, flak damage usually was repairable in a short time. After May 1944 bombers lost to flak exceeded those lost to enemy aircraft, but this represented no great increase in the effectiveness of flak. It was due rather to the negative reason that the enemy fighter force was losing its effectiveness.

The number of bombers damaged and lost to flak rose steadily from August 1942 until October 1944, due to greater numerical exposure which occurred when increasing numbers of bombers were sent out against heavily defended targets. After October 1944 the damaged and lost total fell off. This trend came about mainly because skilled enemy anti-aircraft artillerymen were not available in sufficient numbers to meet the enemy's increasing requirements and later because of shortages of anti-

aircraft ammunition and consequent restrictions on firing.

Other influences included improvement in the quality and quantity of flak intelligence; the use of anti-flak tactics such as tactical bombing of gun positions and firing of Allied field artillery on front-line enemy flak batteries, and counter-measures against enemy range-finding devices.

The percentage of Eighth Air Force bombers which were hit by flak reached a level of about 25 percent of the attacking force by November 1942, fluctuating above and below an average of 25 percent until October 1944. Thereafter, the percentage of bombers hit by flak decreased rapidly, for the same causes given above.

Data now available show that one Eighth Air Force bomber was lost to flak for every ten damaged during the period August 1942 - June 1943; during July 1943 - October 1944, one was lost for every 13 damaged; by the end of 1944, one was lost for every 16 damaged; and by the

end of February 1945, one was lost for every 22 damaged.

German Anti-aircraft Artillery Dispositions: The location of enemy flak guns in the areas of bombing attacks by the Eighth Air Force was well known throughout the war. Rarely did a heavier disposition of anti-aircraft guns turn up than was estimated beforehand. Flak intelligence was of a high order, due to constant use of photographic reconnaissance to locate the enemy guns.

Shifts and increases in enemy anti-aircraft gun dispositions tended to follow variations in target priorities. As Eighth Air Force bombers penetrated deeper into enemy territory and attacked targets in a new category, anti-aircraft defenses built up rapidly around similar targets located within the Eighth's demonstrated range capability.

The magnitude of enemy flak defense is

(CONTINUED ON PAGE 88)

2. CERTAIN FACTORS AFFECTING TARGETS

indicated by the fact that frequently during 1943 the Eighth attacked targets defended by more than 100 heavy guns. In 1944, with equal or greater frequency, targets defended by more than 200 heavy guns were attacked. Around such targets as the Leuna Oil Refinery at Merseburg approximately 450 heavy guns were disposed. In greater Berlin, there were at least 450 heavy guns. In the great Ruhr area, the weight of enemy anti-aircraft artillery was enormous.

German Anti-aircraft Guns and Range-Finding Devices: The standard gun used by the German anti-aircraft batteries through 1940 was the low velocity 88 mm. In 1941 three new guns were in production: the high velocity 88 mm., 105 mm. and the 128 mm. Although the 105 mm. was produced in reasonably large quantities, its output finally was discontinued in favor of the other two models because of technical difficulties with the gun.

At the end of the war over 50 percent of anti-aircraft guns in use by the Germans at that time still were old low velocity 88 mm. models. The low velocity 88 mm. had a maximum effective range of 26,000 feet while the high velocity 88 mm. had a maximum effective range of between 32,000 and 35,000 feet.

Early in the war the Germans relied entirely on visual sighting, but by 1940 they had developed satisfactory radar for the finding of unseen aircraft through cloud and darkness. By this time they also were using a good mechanical predictor with either visual or radar finding.

Accuracy of visual sighting methods was greater than it was for unseen fire. As long as anti-aircraft guns could sight on an individually tracked unit, effectiveness was high. As soon as barrage fire or predicted concentration was resorted to lethal effect became far less.

Flak defenses around targets under constant strategic bombing attack were static. That is to say, they were not equipped with mounts for moving the guns to other targets. These guns could be, and quite often were moved, however, but they had no high inherent mobility, since it was necessary to employ railroad cars or very heavy trucks in the process.

The Large Battery Site: The chief technical development of the war in enemy flak defenses was the large battery site. Some sites had as many as 36 guns, all operating under one tactical control. The Germans claimed certain advantages for these large batteries, but their employment was due, at least in part, to the lack of an adequate supply of gun sighting devices. Another cause was the increasing shortage of highly trained technical personnel as the war progressed.

Variation of Risk from Flak with Altitude of the Bomber: The Eighth learned early in the war that low-level bombing presented a far too dangerous flak risk to be continued. Early attacks at 7,500 and 8,000 feet over St. Nazaire resulted in 100 percent battle damage to the bomber force.

A "rule of thumb" which has remained fairly accurate throughout the war is as follows: risk of a flak hit decreases by half for every 5,000 feet of elevation. Many statistics have been developed and many charts drawn to indicate the degree of vulnerability of individual aircraft and of various sized formations at varying altitudes. However, this "rule of thumb" still gives a reasonable approximation.

One chart produced late in the war shows that the risk of strikes on a close formation of 18 bombers is three times as great at 10,000 feet as it is at 23,000 feet. Similar figures for a single bomber or very loose formation of bombers indicates that the risk is six times as great for a hit at 10,000 feet as it is at 23,000 feet. For the single bomber the risk is cut in two by rising from 22,000 feet to 27,000 feet.

Target Systems: The Eighth Air Force operated under a rigid system of target priorities. This resulted in many attacks on targets where a risk of flak loss and damage was high because the enemy had grasped our target intentions.

Isolated high priority targets, such as Synthetic Oil Plants, generally were most dangerous from the flak point of view. Such targets were very heavily defended with flak batteries. Although the risk of loss and damage was great, these targets had to be

attacked even when the conditions of visibility were such that the expectancy of successful bombing was not great. The concentration of guns around such targets was responsible for mounting bomber losses and flak damage in 1944.

Large city areas containing important manufacturing and communication targets had strong and relatively stable defenses. There was little change in the number and disposition of guns in such locations.

V-weapon installations often were defended by small numbers of highly mobile guns, the positions of which shifted frequently. The situation was further aggravated by the low altitude of attack required for visual sightings and by the overlapping of the flak defenses of these areas.

During periods when the battle line became stabilized, flak defenses adjacent to the line were subject to frequent change. Heavily built up defenses usually were found at communication centers. This situation complicated the selection of routes over battle lines and made great accuracy necessary in selecting headings for the bomb runs on communication targets.

Isolated low priority targets such as airfields in France and Belgium generally were lightly defended. However, the flak defenses underwent periodic changes as importance to the enemy of an airfield increased or decreased. This type of target was dangerous only if attacked from too low an altitude.

Route Planning: Most enemy targets had to be attacked frequently to insure that the damaged status was maintained. Such attacks had to be carried out in spite of heavy concentrations of flak. The risk, however, could be modified to varying degrees by selection of routes for bombing and withdrawal allowing minimum exposure to anti-aircraft fire. Flak intelligence, therefore, was a major factor in route planning. But, as indicated elsewhere in this report, flak was only one of many factors to be considered. The final route usually was a compromise between the safest flak route and one dictated by other operational factors.

(CONTINUED ON PAGE 89)

2. CERTAIN FACTORS AFFECTING TARGETS

Defensive Measures against Heavy Flak:

Bombers can best evade anti-aircraft fire by flying at high altitude and by taking evasive action. But both of these practices are enemies of bombing accuracy. This situation demanded a compromise. In actual practice, formations generally flew at high altitudes but took no evasive action on the bombing run although intensity of anti-aircraft fire there would be severe.

Other measures taken to reduce flak exposure were:

- a. Formations were reduced in size and spaced closer together in trail. This reduced the size of the anti-aircraft gunners' target and tended to saturate flak defenses.
- b. The quality and quantity of flak intelligence was improved.
- c. Constant pressure was exerted to improve navigation and the flying of true courses so that cross winds would not sweep trailing formations over flak defenses en route. Accuracy in navigation also tended to keep aircraft in channels of least flak exposure in target areas.
- d. Aircraft and crews received more and better armor.
- e. Radio counter-measures and the dropping of "Window" were employed to jam enemy gun-directing equipment.

Conclusions: Although the enemy experimented with centimeter wave-length radars, proximity fuzes, and radio-guided missiles and many other things, data now available indicate that the most important source of heavy flak loss and damage was the conventional anti-aircraft gun, controlled and fired by conventional methods.

Radar and Radio Interception

Much of the surprise effect inherent in the use of air power over clouds was nullified by the invention of radar locating devices. Interception by the enemy of radio conversations between aircraft of the Eighth Air Force or between aircraft and ground controls tended further to eliminate the surprise factor.

Radar: The use of large bomber formations required an extended period of assembly at altitude before reaching enemy territory. Radar aircraft detection devices are limited by the fact that their rays follow a line of sight, and distant aircraft flying near the ground are hidden by the curvature of the earth. But even a small number of aircraft (1 to 5) at 20,000 feet over the middle of England can be detected from the coast of Europe. At an altitude as low as 2,000 feet they can be detected by radar 50 miles from the European coast line.

A formation at 15,000 feet having large numbers of aircraft could be picked up by the German radar as far away as 100 miles. Inasmuch as a normal altitude for assembly over East Anglia by the Eighth Air Force was between 10,000 and 25,000 feet, the enemy was in a position to detect and follow the assembly with radar devices for two to two-and-a-half hours before the bombers reached the enemy coast.

Radio Interception: Another important means of intelligence for the enemy was his "Y" Service or interception of radio messages between aircraft and ground controls. Radio Security through radio silence while on missions never was practical in this theater with the size of the force that had to be controlled and coordinated. The radio devices in the aircraft are numerous and complicated. On a large mission, 10,000 to 12,000 men in the bombers have access to radio communication. With the limited amount of radio training which the average crew member received it was inevitable that there were leaks over the radio of information of value to the enemy. Occasionally, remarks intended to be limited to the intercommunication system of the individual aircraft, through crew error, were broadcast by radio.

Neither the enemy nor the Allies was slow to take advantage of breaches of radio discipline by the opposing force. Even where discipline was maintained and codes were used, the codes usually were broken rapidly. The use of map grid systems, with numbered and lettered references to geographical points, delayed the uncoding of intercepts only a matter of hours.

From intercepted radio messages an amazing amount of information was gained both by the Allies and the enemy on matters such as organization, tactics, numbers, units and intentions of the opposing force. One of the finest treatises on the Eighth Air Force, written in

detail and with great accuracy concerning many secret matters was produced by the German "Y" Service. Because of radar detection and radio interception it was practically impossible to conceal a full-scale penetration in depth in this theater.

The bombing of enemy radar devices was considered seriously. No large scale attacks ever were carried out because it was found that the enemy had a large supply of radar equipment and that his reserve to a major degree was allocated to the Western Front. In addition, large radar installations were hard to find and exceedingly difficult to hit. Normally they were built so strongly that nothing but a direct hit would put them out of action for more than a few hours. The majority of installations were small and highly mobile. Attacks on them would have been a waste of bombs.

Radio and Radar Countermeasures: Early in the war highly skilled British technicians played upon the limitations of enemy radar devices and radio interception with great success. Radar detection is limited seriously in the adequacy of information it produces. The enemy attempted to increase his information by multiplying the number and type of devices in use. The information so gathered was evaluated at a control and it made possible estimates of numbers, types, speeds and direction of flight of both American and British aircraft. However, radar devices could not detect specific numbers with even approximate accuracy until the aircraft were within a few miles. German controllers determined types of aircraft from speed, altitude, the nature of the reflected spot seen on the scope, and the area in which the aircraft first were seen. Headings were established with fair accuracy. The area from which aircraft took off was easy to detect unless measures were taken to confuse the enemy by "spoofing".

With a huge force of bombers, such as the Eighth Air Force operated, the difficulties involved in attempting to "spoof" or confuse the enemy are great. Sometimes, however, startlingly successful results were accomplished with the aid of special equipment to jam enemy interception of radio messages. For example, on 27 November 1944, the enemy de-

(CONTINUED ON PAGE 90)

2. CERTAIN FACTORS AFFECTING TARGETS

tected what he thought were Eighth Air Force heavy bombers headed across the Zuyder Zee towards Berlin. He later found to his dismay that what he had believed to be a bomber force was almost the entire fighter force of the

Eighth Air Force. This resulted in a serious defeat for the Luftwaffe which it could ill afford to take. Special jamming devices were sent out over the North Sea in Eighth Air Force aircraft during this mission.

3. CAPABILITIES OF THE AIR FORCES

Eighth Air Force - Bombers

The capabilities of a great bomber force, flown in formation, are a combination of the capabilities of its units and those of the aircraft in the units. The individual capabilities of an aircraft naturally are modified when it is flown in a formation and still further modification results when several formations operate as a Task Force.

The B-17 or Flying Fortress

The Boeing B-17 aircraft of the present actually is a modification and improvement of the 1934 B-17 design. Many attempts were made in many countries to design a more capable bomber after that time, but the B-17 still is without a peer in its class for combat in the European Theater.

The manufacturer designed the aircraft for a maximum gross load of 48,000 pounds. With such a load, the B-17 could indicate over 200 miles per hour, and at optimum altitude, make a true air speed of over 300 miles per hour. It could climb to well over 40,000 feet. Its range was as great as 2,500 miles.

Combat requirements, however, placed more and more overload on the B-17. Increasing enemy capabilities at various times brought about the addition of more turrets, armor and armament. This entailed adding to the crew and increasing the already great weights of ammunition to give sufficient duration of fire. The considerable distances from available bases to vital enemy targets made the carrying of large amounts of fuel necessary. Additional communications equipment was added. Large bomb loads were essential.

With each addition to the overload, the B-17 gained certain capabilities, but each

entailed the loss of some other characteristic in the initially superb performance of the B-17. Speed and maneuverability were reduced; climb and ceiling were lowered; range was cut.

During the first year of the air war with Germany, gross loads rose above 55,000 pounds take-off weight. Thereafter, extra fuel tanks were added. Eventually, the B-17 was taking off with gross loads up to 65,000 pounds, or $8\frac{1}{2}$ tons overload. What did all this do to performance?

With standard tanks and a 55,000 pound gross weight, the B-17 could fly 1,800 miles at 10,000 to 12,000 feet altitude. Direct penetrations into enemy territory, however, required climbing to 20,000 feet or higher over England and assembling into defensive formations before heading for the enemy coast. This procedure was made necessary by the accuracy and range of enemy anti-aircraft batteries situated along the coast, and by the habits of enemy fighters. At one time the fighters came out to sea to meet Eighth Air Force formations.

This climb and assembly used up both time and fuel, and the jockeying, necessary to hold formation, used up still more fuel. There was consistently a strong wind at this altitude which further reduced the effective radius of operations.

To give some impression of the useful range of the B-17 under combat load and combat conditions, the term "Practical Range Capability" was coined. This term means "the range of the B-17, after altitude assembly, flying in formation at given settings, directly into enemy territory and with direct withdrawal". The conditions set were as follows:

It is evident that the field of radio and radar deception is a highly fruitful and important one for any air force to exploit whether it be on the defensive or the offensive.

For B-17 with Standard Tanks:

Fuel capacity	1,730 gallons.
Gross weight (including 5000 pound bombs)	55,000 pounds.
Climb, at 140 mph I.A.S. immediately to	25,000 feet.
Assembly time	60 minutes
Flight to target and return, at altitude at	155 mph I.A.S.
Let down, commencing 160 miles from base at 500 feet per minute and 170 mph I.A.S.	

Such conditions permitted a depth of penetration of approximately 360 miles beyond the enemy coast and return, this range being calculated from fuel consumption records compiled over many months of combat.

When the climb could be made over the North Sea or the Atlantic Ocean, range was, of course, extended. Hence the curves in the lines on the chart extending the range eastward along the North German coast, and southward in France along the coast on the Bay of Biscay.

For the B-17 with Tokyo Tanks (or wing tanks): Fuel capacity rose to 2,812 gallons and gross weight (including 5,000 pounds of bombs) to 63,000 pounds. This fuel capacity and load, for the same conditions as before gave a penetration beyond the enemy coast line of 630 miles and return.

So much for range. What were the other characteristics and capabilities of the B-17?

The aircraft has excellent stability. It is strong and will absorb great battle damage before control is lost. Its air-cooled engines

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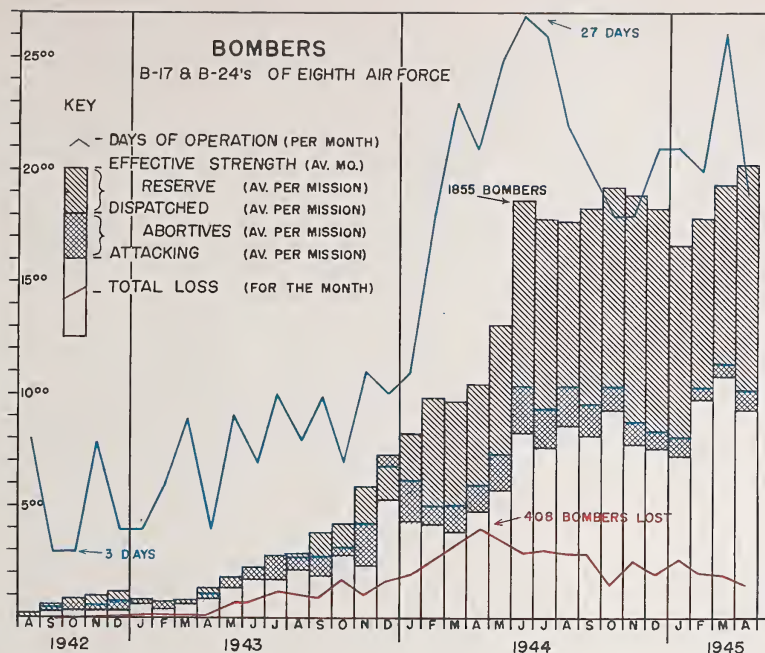


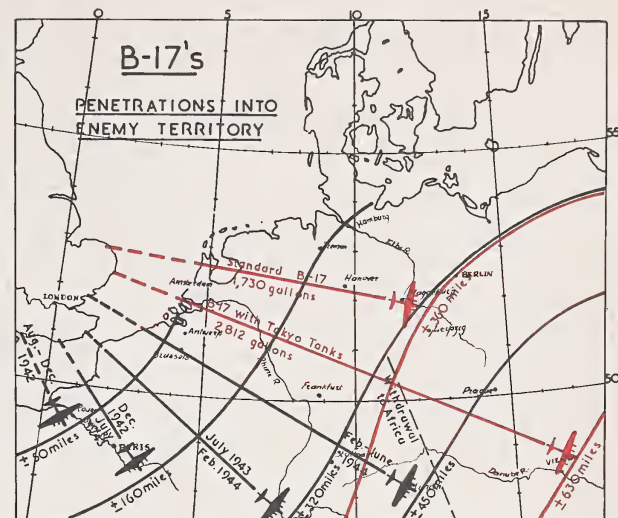
Chart A. Bombers - B-17s and B-24s of Eighth Air Force.

Days of Operation per Month. During the early part of the war, Eighth Air Force bombers were capable of bombing only on days when visual bombing conditions prevailed, and when take-off and landing conditions permitted operations under the then - limited experience of crews. The rise in days of operation reflected increasing capabilities, which had been brought about by means of overcast navigation equipment and techniques, and improvement in ability to fly in bad weather.

Effective Strength, Dispatched, and Attacking. Clear or shaded bars, show growth of the force and its operational use. The difference between the number of aircraft dispatched on a mission and the number which attacked targets, represents "abortives" which turned back for various reasons, such as failure of equipment. All these figures represent daily averages for the actual missions flown during the month.

In some of the early months, the figure for bombers dispatched is higher than the effective strength. This shows the tremendous effort made to put the maximum possible force in the fight against Germany. Every aircraft was dispatched which could be made to fly, even with pick-up crews, and the rate of abortives was unusually high.

Total loss for the month represents bombers destroyed or lost in action. This is not an average figure.



COMPARISON OF PRACTICAL RANGE CAPABILITY
WITH DEMONSTRATED RANGE CAPABILITY
AUG. 1942 - MAY 1945

Chart B. B-17s Penetrations into Enemy Territory

"Practical Range Capability" (shown in red) is a coined term meaning "the range of the aircraft after altitude assembly, flying in formation, at given settings, directly into enemy territory, and withdrawing on the reciprocal route." This range represents the approximate maximum penetration which the commander can expect from his aircraft and crews under those specific conditions.

"Demonstrated Range Capability" (shown in black) is another coined term meaning "the maximum penetration during the period indicated, demonstrated to the enemy as our capability."

These demonstrated range capabilities will be found to have a correlation with the range of American escort fighters (shown in Charts A and B, page 97). In the first half of the war, Eighth Air Force bombers flew varying penetrations beyond escort range of progressively increasing depth. As the enemy improved his powers of interception, bombers were forced to conform more closely to the range and strength of the escort force.

The phases of enemy disposition (shown in Charts A on pages 107, 111, 119, 127 and 135 and in Charts A and B on page 141) will be found to be the resultant of our "demonstrated range capability" and the major enemy target areas, (shown in Chart A, page 105). This is true except for the last enemy disposition shown (Chart B, page 141) when Allied invasion forces dominated enemy air dispositions during the crucial beach assault phase.

3. CAPABILITIES OF THE AIR FORCES

continue functioning after many hits by enemy guns. It will fly to 30,000 feet and still hold formation.

Its chief limitations are: first it has poor pilot visibility, which makes formation flying difficult; and second, it catches fire fairly easily when struck by enemy fire, either fighter or flak. Both of these characteristics were known; but no additional improvements were practicable which would not reduce overall combat capabilities.

A further limitation came as the direct result of over loading. The B-17 under full combat load is capable of only minor speed variation without risk to the motors and considerably increased fuel consumption. Such a small variation in allowable speed made the flying of huge formations very difficult, but the loads were necessary for exploitation of the airplane.

The B-24 or Liberator

The significant differences between the B-24 and the B-17 are: The B-24 is slightly faster; is not quite so stable in flight at high altitudes; has poorer visibility; and is slightly more vulnerable to enemy fire. It carries a slightly larger bomb load, and it has greater range of flight; for its standard tanks take it nearly as far as the B-17 with extra wing tanks. With wing tanks in the B-24, its range is even further extended.

The Crew

The performance of a bomber crew depends largely on the amount of training received, and the amount of training possible in war time is limited by many factors. The goal is not theoretical perfection, but rather adequacy to defeat the enemy.

A summary of training, based on experience in the European Theater may have some value.

Pilots received the most adequate training of the officer crew members. A higher degree of competence and experience instilled into navigators and bombardiers before they arrived in the Theater of Operations might have paid

profitable dividends. This was particularly true because of the limited opportunity for additional training in the theater. Virtually all suitable weather was used to fly operational missions. There was less opportunity to check performance on combat missions than in training practice.

The same was true of the enlisted personnel as of the officers. Gunnery performance could have been stepped-up faster in training than was possible in combat, because errors in performance can be discovered and corrected in training which rarely can be in combat. The high returns from skillful operation of gun turrets, difficult of manipulation, indicated that training of gun-turret operators before arrival in a theater could be expanded with profit.

Radio operators, upon arrival in the United Kingdom found a multitude of devices and techniques in use which were new to them. Inexperience with the equipment and devices in use in the theater and limited opportunity for further training, handicapped the Eighth's communications.

Units which strayed from the main column of bombers on missions were a source of a high percentage of total bomber losses during much of the war. To what extent such deviations from course could have been prevented by a high level of performance in navigation and communications is problematical. But any improvement would have tended to reduce the total loss.

The Bomber Formations

To oppose German fighter defenses effectively during daylight penetrations over the continent, large bomber formations were tactically necessary for the massing of defensive fire against concentrated fighter attacks, and to increase the capabilities of our escort fighters.

Certain disadvantages, however, had to be accepted. For instance, on direct penetrations during the decisive phase of the air war it took two-and-one-half hours to assemble a formation and reach enemy territory. This, as mentioned in the previous section, gave the enemy early warning of an impending operation.

Formation flying restricted maneuverability too, with a result that evasive action was limited.

Formations presented better targets to enemy anti-aircraft fire than single aircraft. The requirements of formation flying limited the altitude of flight.

Enemy flak strength and disposition forced the Eighth Air Force to fly mostly column formations throughout all of German held Europe. Within this column the propeller-wash from huge formations required extended spacing between units, thus elongating the column of bombers and thereby increasing the difficulties of escorting fighters.

Our Bomber Force

Capabilities of the bomber force of the Eighth Air Force as a whole continued to expand until June 1944. It was early discovered that bomber fire power alone was insufficient defense against as determined a fighting force as the German Air Force. Even had our bomber force been the size later attained, it would have been unable to penetrate unescorted to targets deep in Germany without suffering prohibitive losses. Additional fire power, both mobile (relative to the bombers) and flexible, was required.

Hence, capabilities of the bomber force were geared almost directly to fighter escort. When sufficient long-range fighters were available, the bomber force could penetrate to deep objectives. Before the arrival of long-range fighters, the few attempts of the Eighth Air Force to penetrate enemy defenses to depth beyond escort range met with large losses. Such operations could not be sustained.

Bomber formations represent units tactically defensive. They have all of the inherent disadvantages of the defensive. The enemy fighter force, with superior performance, can effect a concentration at will against that portion of a column which he thinks he can defeat. A counter to this enemy capability had to be provided in order to survive sustained operations involving deep penetrations of Germany's strong fighter defenses. The escorting fighter was the Eighth Air Force's solution.

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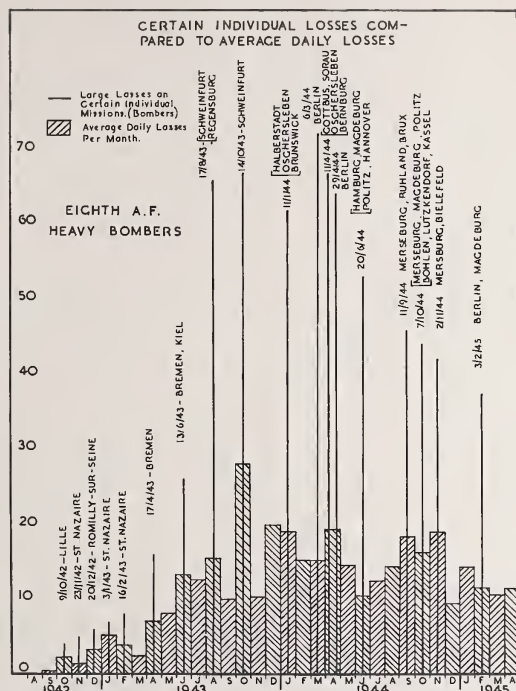


Chart A. Certain Individual Losses Compared to Average Daily Losses

In this chart, certain bomber losses which were large, for that period of the war, are compared to the average bomber losses for the month. The average was obtained by taking the total number of bombers lost for the month and dividing by the number of days on which missions were flown. Losses were those reported plus Category E damage.

October 1943, was the month of largest average loss by the Eighth Air Force. An average of 28 bombers per mission was lost. Immediately thereafter average losses drop and fluctuate between 10 and 20 bombers per mission, for the rest of the war.

Two facts are noteworthy: In October 1943 the period of deep penetration far beyond the range of escort ended. For a short time, penetrations were considerably reduced. By January 1944, long-range escort fighters began to be available in increasing volume. In February 1944, for the first time, deep penetrations could be flown with part of the escort force accompanying the bombers during the entire route.

The largest loss for any single mission was on 6 March, 1944 when 72 bombers were lost during an attack on Berlin. But the bomber force had grown to such proportions that, despite 23 missions flown during March 1944, the average loss per mission was only 15 bombers.

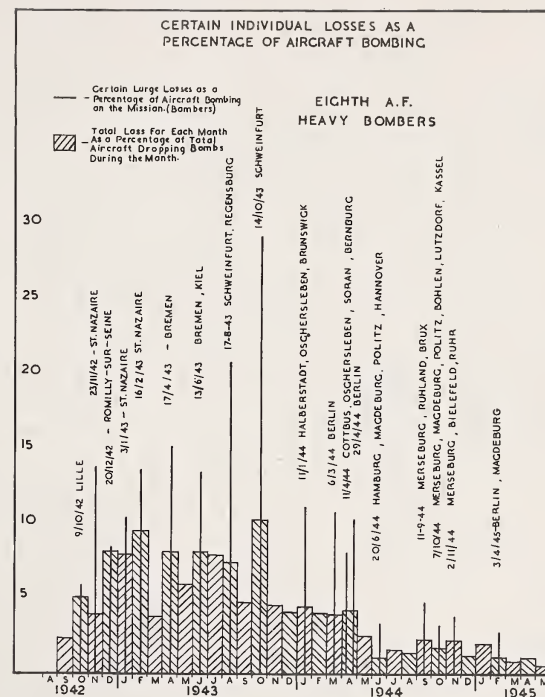


Chart B. Certain Individual Losses as a Percentage of Aircraft Bombing

Here, data presented on the previous chart are related to the size of the attacking bomber force. To illustrate, on 14 October 1943, when 66 bombers were lost, this number represented 28 percent of the aircraft bombing at Schweinfurt on that day. Similarly, an average of 28 bombers was lost per mission, during October 1943, and this represented just over 10 percent of the average number of bombers attacking targets each mission during that month.

This tells the story of the Air War with Germany in terms of percentage losses. In 1943, when the Eighth Air Force's force of bombers was small and escort short range, the enemy could inflict losses of around 7½ percent of the number of our aircraft actually bombing targets. In the 6 months ending with April 1944, he could inflict average losses per mission of around 4 percent of the force bombing. This drop was caused by advent of long range escort, actual growth of our bomber force, and great relative growth compared to enemy fighter opposition. It was accomplished in spite of the fact that the number of days of operation had been stepped up from about 8 per month to over 20 per month in March and April, 1944.

For the rest of 1944 and 1945, losses averaged only 2 percent per mission of the force bombing. Such a percentage loss indicates harassing attacks by the enemy rather than effective opposition.

3. CAPABILITIES OF THE AIR FORCES

Since the bulk of the air war took place over enemy territory, the enemy's knowledge of the situation during a mission greatly exceeded our own. The German reporting system gave enemy fighter controllers a fairly clear picture of the situation, while the Eighth's knowledge of the enemy was limited at first to visual observation from each aircraft, and to some limited interchange of information by radio between the units. The enemy fighters were constantly advised by their controllers of the size, location, and direction of flight of each of our bomber formations and fighter units. Eighth Air Force fighters on the other hand, were not warned of enemy fighters approaching the bombers until these came within visual range.

Late in the war, after the Allies had occupied extensive territory in Europe, a fighter control system was used by the Allied Forces which gave excellent results as far as 200 miles into Germany. It was called Microwave Early Warning, and immediately gave radar extension to the eyes of our fighter pilots. With this control the Eighth Air Force was able to fight with better information within the limit of radar range.

Another source of intelligence paid dividends. This was airborne "Y" Service, or radio equipment to intercept enemy control messages. The information obtained from this airborne "Y" was used largely after the mission to gain knowledge of enemy order of battle, tactics and control methods. Airborne radio interception provides a lucrative field for battle intelligence. Its use was limited in the European Theater, both by the initial lack of equipment and of trained German-speaking operating personnel.

Rate of Bombing Operations

At the beginning of the war the number of bombing operations per month by the Eighth Air Force was severely restricted by weather and lack of escort range. Toward the end of the war the weather problem had largely been overcome (see Section 2 of this chapter), and the range and number of escort were such that Eighth Air Force bombers had the capability of attacking any target in Germany.

Bombing Range

The demonstrated range of our bomber forces varied in the different phases of the war, (for a detailed discussion see Section 4 of this chapter). From August to December 1942, the Eighth Air Force was limited to very shallow attacks up to 50 miles beyond the enemy coast line. On 12 December 1942, an attack was made on Romilly, thereby effecting a penetration of 160 miles into enemy territory. This did not represent addition of new equipment but resulted in part from increased size of the bomber force. Until 24 April 1943, this penetration was not exceeded.

On 25 April 1943, an attack was made at Rostock indicating that the Eighth Air Force had extended its old capability.

On 17 August 1943, the Eighth Air Force made attacks on Regensburg and Schweinfurt. The force sent to Regensburg, equipped with Tokyo tanks, returned, not to England, but to Africa. This force demonstrated the capability, through use of such tanks, of attacking anything in Western Germany and all of France and Italy. The force penetrating to Schweinfurt consisted of B-17s with standard tanks. It returned to England. This force demonstrated the capability of penetrating some 320 miles into enemy territory and returning to the United Kingdom. This was not exceeded until 20 February 1944. However, this first attack on Schweinfurt, and a later attack on 14 October 1943, both resulted in such severe bomber losses that the Eighth's bomber force clearly could not carry on sustained operations of this nature. After both missions, a period of repair and recuperation was necessary before attempting another large scale attack.

On 20 February 1944, Eighth Air Force bomber formations, accompanied by long-range escort, penetrated to Leipzig. Then on 19 March 1944, bombers with escort attacked Munich, demonstrating a new range capability of 450 miles penetration into enemy territory. This was not exceeded until June 1944.

On 21 June 1944, while several Task Forces flew against oil targets near Leipzig, one of the forces, accompanied by P-51 escort, attacked an oil plant at Ruhland, north of Dresden,

and continued eastward to the Russian air base at Poltava. This force showed to the Germans that the Eighth Air Force now was capable of attacking anything in Germany.

Eighth Air Force - Fighters

The Fighter Force of the Eighth Air Force may be divided into two distinct categories: the shorter ranged P-47s (Thunderbolts) and the longer ranged P-38 (Lightning) and P-51 (Mustang).

The P-47 or Thunderbolt

The range of the P-47 was variable, depending upon the size of the external fuel tank carried (see Chart A, page 97). Its maximum range for escort purposes was 475 miles from base, reaching, roughly, to Magdeburg. This range was possible only when two 108 gallon wing tanks were carried.

The roomy cockpit of the P-47 provided comparative comfort and ease for the pilot. Firepower of this aircraft was great: 8 machine guns of .50 calibre. On level flight the aircraft was the least speedy of American fighters, but it was the fastest in a dive.

The P-47 was very rugged and could stand considerable battle damage. Its radial engine would function even after many hits by enemy fire. Its combat characteristics were good in spite of the aircraft's great weight.

The P-38 or Lightning

The P-38 equipped with two 108 gallon wing tanks, could escort as far as 585 miles from base (see Chart B, page 97). The cockpit was fairly comfortable. The firepower consisted of four .50 calibre machine guns and one 20 mm. cannon. The aircraft was fast in level flight and had the best climb of American fighters. It dived well. Its combat characteristics were good; exceedingly fast turns could be made by varying the speed of its two motors.

Its distinctive appearance sometimes was a serious disadvantage in combat, for an enemy pilot easily could recognize the aircraft long
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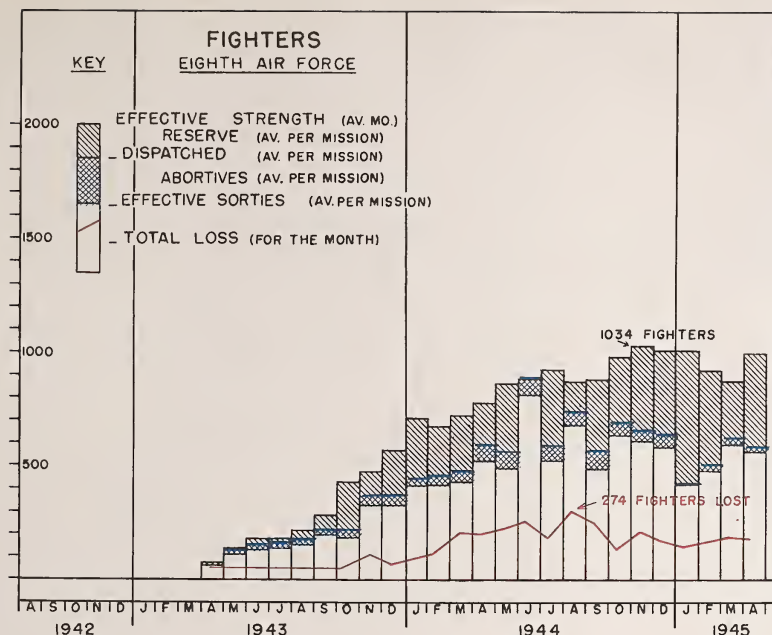


Chart A. Fighters - Eighth Air Force.

Effective Strength is an average figure for each month. This shows the growth of our operating fighter force.

Dispatched and effective sorties are both given on a per mission basis. The difference between dispatched and effective sorties gives the number of abortives averaged per mission during the month.

Total loss for the month is the number of fighters lost to enemy action or otherwise during sorties into enemy territory.

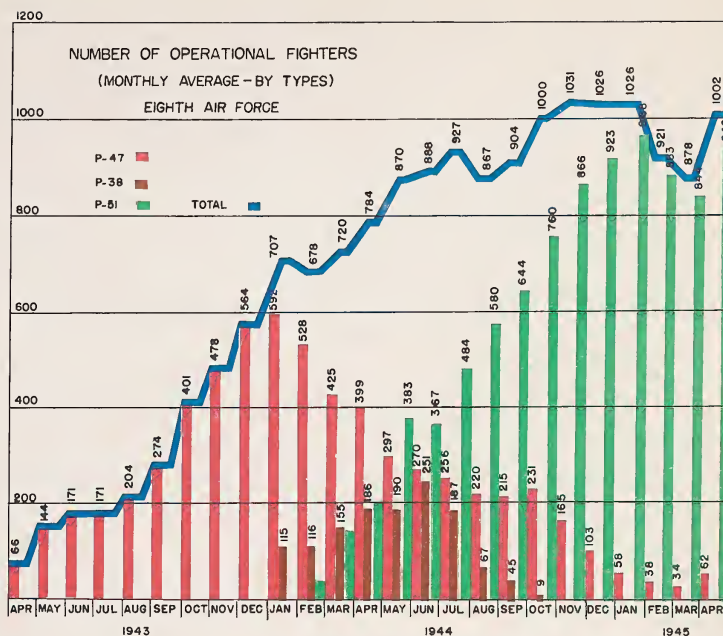


Chart B. Number of Operational Fighters.

Early growth of our fighter force was limited to one type, P-47s, which at that time were of limited range.

In January, 1944, P-38s began to make their appearance, and in February, P-51s appeared. The special utility of the P-51 for the requirements of this theater, caused it to be preferred for most duties to the other two types. Similarly, there were certain deficiencies in the P-38 for the specialized uses in the air war in this theater which caused its use to be discontinued.

Toward the end of the war in Europe, the P-47 had been improved to the point where it could make sweeps across enemy territory, even flying beyond Berlin. Because of its formidable firepower, rugged construction, and the persistent functioning of its air-cooled radial engine, even after much damage by enemy fire, the P-47 was never eliminated but continued to give excellent results in skilled hands to the end of the war.

(Note: P-38s had been delivered to the Eighth Air Force in 1942 in small numbers, but they were then withdrawn for use in the African campaign before they could be used for escort in the European Theater of Operations).

3. CAPABILITIES OF THE AIR FORCES

before a P-38 pilot could recognize the enemy. This frequently cost the P-38 initiative in combat.

Although the aircraft had excellent performance at low and medium altitudes, this deteriorated at high altitudes.

The most serious disadvantage of the P-38 was the vulnerability of its liquid-cooled engines to enemy fire. An enemy bullet in the cooling system resulting in loss of the coolant fluid promptly eliminated that engine. The P-38 could fly reasonably well with a single engine, however, and such an accident did not necessarily mean the loss of aircraft and pilot.

The P-51 or Mustang

The P-51 was the outstanding escort aircraft in the aerial war with Germany. With two 108 gallon wing tanks it could escort 850 miles from its base (see Chart B, page 97). On one occasion P-51 escorts met bombers deep in Poland, flew escort north to the Baltic and all the way back leaving the bombers only after the west coast of Denmark had been crossed, as mentioned earlier. P-51s escorted the bombers on the shuttle mission to Russia.

The P-51 was the fastest Eighth Air Force fighter in level flight, and it also was fastest at high altitudes. Its cockpit was fairly comfortable, and the aircraft was highly maneuverable.

The fire power of the P-51 was the least of all our fighters. Early models carried four 50 calibre machine guns. Later in the war the number rose to six.

The most serious disadvantages of the P-51 were that its airframe was the least rugged of the three, and that its single liquid-cooled engine made it the most vulnerable to enemy fire.

The combined capabilities of the P-51 made it far the best all-round escort aircraft but the great strength and fire power of the P-47 made it the most feared within its range, both for escort and for strafing.

Capabilities of Enemy Fighters

The capabilities of the German Air Force will be treated by considering the following factors:

- (a) Enemy Fighter Aircraft.
- (b) Armament and Effectiveness of Enemy Fighters.
- (c) Air Crews and their Training.
- (d) War Experience of the German Air Force.
- (e) The Enemy Fighter Control System.
- (f) Enemy Pilot Morale.
- (g) Factors in Enemy Fighter Dispositions.

(a) Enemy Fighter Aircraft

There are four main classes of enemy fighters to be considered; single-engine fighters, twin-engine fighters, jet and rocket powered aircraft.

Single-Engine Aircraft: The great bulk of the enemy's single engine fighters were Fw-190s and Me-109s.

There was very little speed difference between the Fw-190 and fighters used by the Eighth Air Force although our fighters generally had a slight edge. The Me-109 was slightly faster than the Fw-190 particularly at high altitudes, but otherwise had much the same performance.

In general, United States fighters could out-dive the enemy and his could out-climb and out-maneuvre ours. With pilots of equal ability and with equally sound employment of the fighter forces, it might have been a fairly even fight. However, United States fighters had much more endurance and a greater weight of firepower, and in general were less vulnerable to opposing fire. And most important, the tactical employment of Eighth Air Force fighters was much more sound.

The early success of the Me-109 and Fw-190 was a factor which acted as a deterrent to improvement in German fighter design. Early models of these fighter types had experienced little difficulty in Poland in the 1939 campaign. Success against the Lancaster daylight raid to Augsburg on 4 April 1942 caused the enemy to develop a false feeling of invincibility.

When, later it became apparent that Allied air forces were gaining ascendancy in the air over Germany's current orthodox types of fighter aircraft, the enemy resorted to desperate efforts to accelerate the development and production of new radical types - the jets and rockets. With these designs he had strong hopes of outclassing our orthodox types and regaining air superiority over the Continent.

Twin-Engine Aircraft: The bulk of twin-engine aircraft of orthodox type used by the enemy were Me-110s, Ju-88s, and Me-410s.

The Me-110 and the Ju-88, were general purpose fighters. They were used for night fighting, bombing, reconnaissance, and other purposes. The Me-110 was the older plane, slower and more vulnerable. The Ju-88 was the more flexible in use and faster. Neither aircraft was much of a threat to unescorted bomber formations until equipped with rocket motors, which made them highly lethal weapons. The advent of P-51 and P-38 long range escort made Germany's orthodox twin-engine fighters obsolete rapidly.

The Me-410 represented an improvement in speed and firepower over the old Me-110; but its advantages were not sufficient to cope with the Eighth Air Force's fighter escort. Rocket firing Me-410s, if not faced by escort fighters, were powerful weapons against our bomber formations. Had the Me-410 been equipped with adequate range finding devices, the rocket mortar, already a highly lethal weapon, would have been even more effective.

Jet Propelled Aircraft: The jet propelled Me-262 in time, undoubtedly, would have become a very serious threat, demanding a counter weapon of similar type in the Allied forces. Jet propulsion still was in an experimental stage. United States air successes, however, precipitated an attempt to make production models for immediate war use despite many imperfections. The Me-262 had high speed, well beyond the speed range of our fighters, and its endurance was at least 2½ hours. Its maneuverability was good for its speed, and its firepower, consisting largely of 30 mm. cannon, was lethal against our bombers but was not a match for our .50 calibre machine guns, in fighter against fighter combats. Our weapons had higher muzzle velocity, rate of fire, and volume of ammunition. The 30 mm. cannon was designed primarily to attack bombers.

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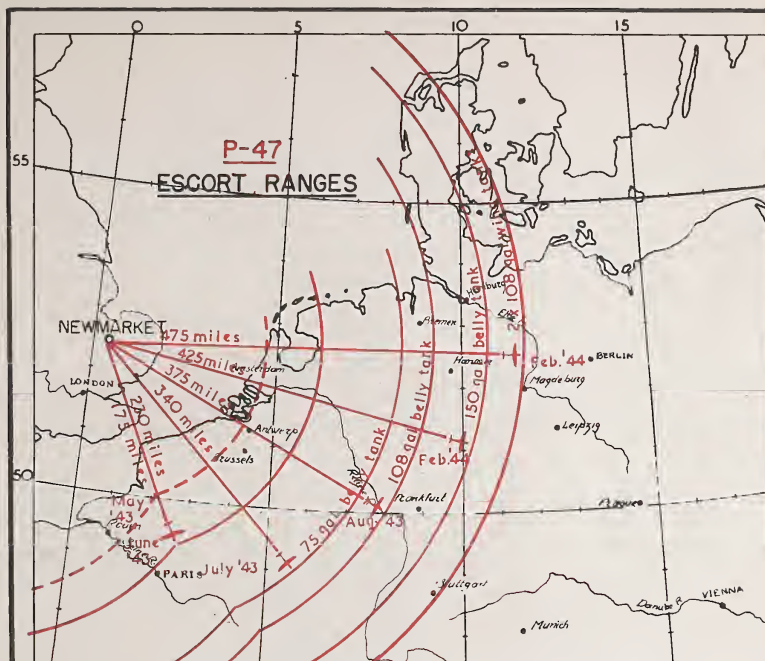


Chart A. P-47 Escort Ranges.

In May 1943, P-47s began to join the Spitfires in escorting Eighth Bomber Command's missions. At the start, their range was about as restricted as the Spitfire. A distance of around 175 miles from Newmarket or Salisbury and return, was about their maximum range.

During the months of May and June, our fighter pilots gained experience, and modifications to equipment now gave them additional confidence in their aircraft. During June 1943, the radius of action of the P-47 was expanded to 230 miles from the base area.

The first practical drop tanks of 75 gallons fuel capacity were added in July 1943. The radius of action now was extended to 340 miles from bases. The tactical surprise gained by the increased range was used to good advantage, enemy aircraft were shot down in larger numbers on the first two days it was demonstrated.

In August 1943, 108 gallon belly tanks extended the radius of action to 375 miles from bases.

February 1944 saw the 150 gallon belly tank in action again extending the radius of the P-47 to 425 miles. In the same month, earlier experiments came to fruition; two 150 gallon tanks were mounted on the wings of the P-47, giving them their ultimate escort radius of 475 miles.

P-47s equipped with wing tanks could fly much further than the ranges given above when not on escort duty. During sweeps, they ranged even beyond Berlin.

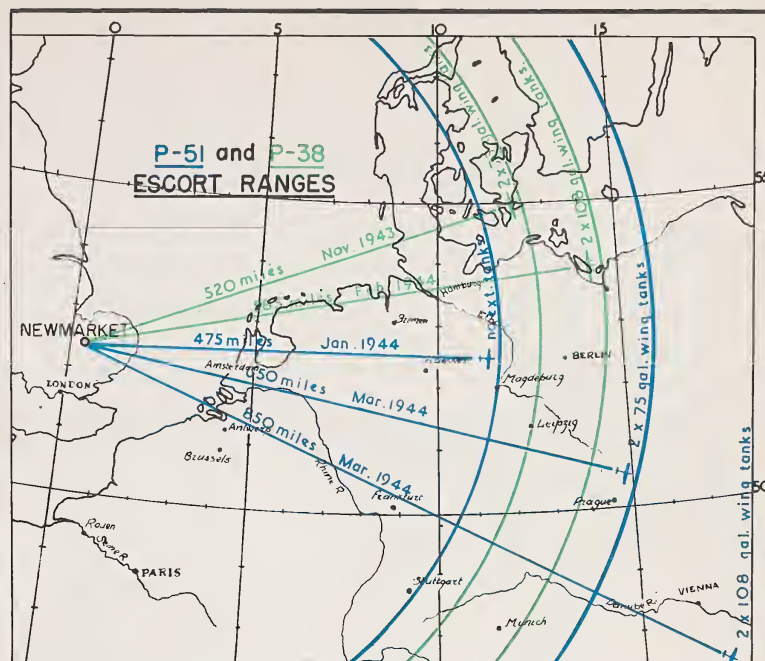


Chart B. P-51 and P-38 Escort Ranges.

P-38s began escorting in small numbers in November 1943. Equipped with two wing tanks of 75 gallons each, the P-38 could escort 520 miles from base.

In February 1944, two wing tanks of 108 gallons each came into use. With this increased fuel, radius of action of the P-38 was extended to 585 miles from base.

P-51s. In January 1944, a few P-51s began escort duty. Without external tanks, the P-51 could escort to a point 475 miles from base. It is noteworthy that this is the same as the ultimate escort range of the P-47 equipped with two 108 gallon wing tanks.

In March 1944, both 75 gallon and 108 gallon wing tanks became available. With two 75 gallon wing tanks, the P-51 could escort to a point 520 miles from base. With two 108 gallon wing tanks, it developed the phenomenal escort range of 585 miles.

With such equipment, the P-51 permitted the exploitation of the full range capabilities of the heavy bomber force.

(Note: Escort ranges given for our three types of fighters are believed to be fair comparisons).

3. CAPABILITIES OF THE AIR FORCES

The premature commitment of the Me-262 resulted in frequent accidents in training with the loss of highly skilled pilots, which the enemy, at the time, could ill afford to lose. Diversion of a portion of his Me-262s to strafing and dive bombing further reduced the effectiveness of this new weapon against our bombing operations.

Rocket Propelled Aircraft: The rocket propelled Me-163 represents an outstanding failure of the enemy. Although the Me-163 demonstrated remarkable speed at full power, endurance was exceedingly brief, being limited to some 10 to 12 minutes of full power flight. It lacked maneuverability under power but could glide extensively. If the pilot used a long glide after a short burst of power, the aircraft could be flown something over an hour. This represented a distinct range limitation. Because of special fuel and equipment required at bases, the Me-163 was a weapon which had to be fired from a point at objectives within its limited range. Even had the Me-163 mounted far heavier weapons, its limitations of range and maneuverability would have given it little improvement in effectiveness. As it was, many Me-163s were shot down by orthodox fighters with negligible success on the part of the Me-163.

(b) Armament and Effectiveness of Enemy Fighters. (See Charts A and B Page 99;

By the beginning of 1944 the policy adopted by the German Air Force High Command was to direct fighters at Eighth Air Force bombers and avoid or evade the escort. Later, near the end of the war, German fighters assigned to intercept bombers received fighter escort, designed to engage our fighters while the bombers were under attack. With this objective - bomber destruction - the Germans continually increased the calibre of weapons, as already has been noted in connection with the Me-262. These larger weapons, while more effective against our bombers, reduced effectiveness against fighters.

Chart B, Armament of Enemy Fighters, page 99, shows that the ratio of cannon fire to machine gun fire from enemy fighters increased about 300 percent in just two years.

The number of bombers known to be destroyed by enemy fighter attack rose strongly. This was due to increased weight of armament, increased numbers of enemy fighters and, also, to the increased number of bombers subjected to attack.

The other chart on the same page underlines this conclusion (See **Chart A, Effectiveness of Enemy Fighters,** page 99). Bombers known to be lost to enemy fighter attack increased in about the same ratio as the increased weight of his armament. But the percentage of bombers which attacked targets in enemy territory and which were destroyed by enemy aircraft, fell sharply in the period September-December 1943 and continued downward throughout the rest of the war. In the last half of 1944, the percentage became negligible. The growing weight of attack by Eighth Air Force bombers and fighters, together with improved tactics of employment, steadily robbed the enemy of his ability to make effective interception and never permitted him to recover.

(c) Air Crews and their Training

By the early spring of 1944, it became apparent to the Eighth Air Force that the experience level of German fighter pilots of that date was well below that of the pilots of 1942. Their experience and aggressiveness was not adequate to engage an average Eighth Air Force fighter pilot on anything like equal terms.

The background to this situation is not entirely clear at this time. As far as can be determined, the German Air Force never permitted a numerical shortage of pilots to render any first-line units non-operational for any extended period. It became increasingly apparent that throughout the war the enemy preferred to compromise with training standards in preference to allowing operational strength to diminish. The adoption of this policy ultimately vitiated the combat capabilities of the German Air Force.

In order to supply the pilots required by operational units in adequate numbers, the Germans resorted to two main devices:

(1) Between 1942 and 1944 training hours in the air which a new fighter pilot received before joining his operational unit, dropped from 210 to 112. The curtailment was effected as follows:

	1942	1943	1944
"A" (Elementary Flying Training) School	100	70	52
Fighter School	60	60	40
Operational Training Pool	50	16-18	20
Total Hours:	210	136-138	112

(2) In the early part of 1944, a conversion to fighter pilots of bomber pilots, staff pilots, and instructors from schools, was commenced. This conversion course was compressed into approximately one month of training, at the end of which the pilot reported to an operational fighter unit.

A flow of "trained" pilots to operational units was maintained sufficient to keep the supply of pilots for aircraft in balance. However, the quality of the pilots became progressively worse. This progressive deterioration may be explained by (a) the shortening of the training program and (b) the use of men who originally had been considered more suitable for operations in types of aircraft other than fighters.

In addition the following factors also had the effect of lowering operational efficiency of fighter units:

(1) The German High Command did not stick to a consistent policy of operations for its fighters. Early in 1942 the German fighter pilot frequently was in air combat against Allied fighters. When the threat of attack by heavy bombers became acute, for a time all training and other efforts were directed toward developing the best method of attacking bombers. German pilots were ordered to pay no attention to Allied fighters, but to attack four-engine "heavies" and in some cases the mediums. Later many fighter pilots were assigned to ground support missions. German pilots soon lost the art of "dogfighting", and became no match for the Allied pilots who continually perfected their individual fighter versus fighter tactics. From time to time German fighters were detailed to attack the escorting fighters. When they did so, their lack of training for this job became more evident.

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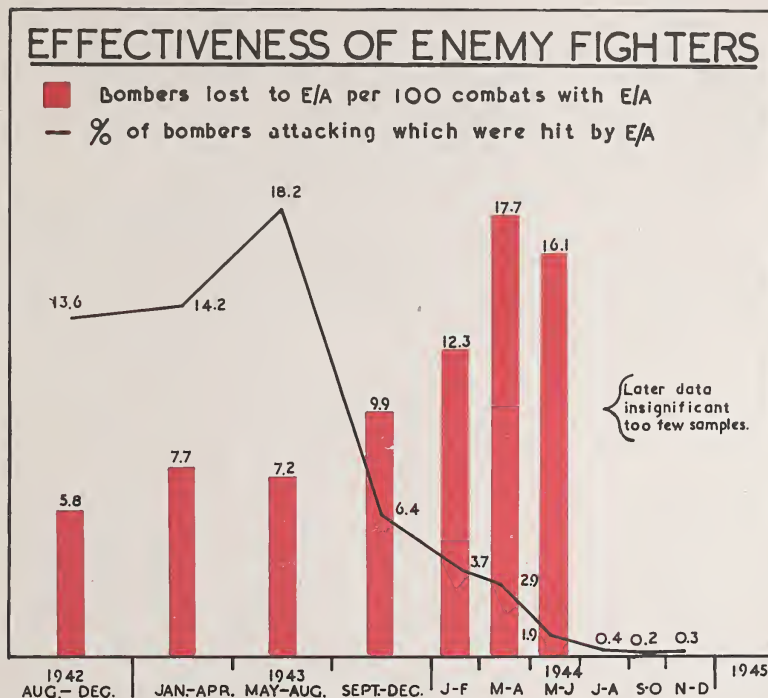


Chart A. Effectiveness of Enemy Fighters

The rise in the number of bombers destroyed per hundred combats was due to the increasing destructive power of the individual enemy fighter. This destructive power resulted in part, from better enemy tactics, and in part from increased weight of armament of enemy fighters, (as described in the following chart).

The solid line on the above chart is the best measure of the effectiveness of the enemy fighter force as a whole in intercepting our bombers.

It should be noted that the percentage of bombers attacking which were hit by enemy aircraft increased during the period when growth of the Eighth Air Force's bomber force was relatively slow, and the German Fighter Force was expanding rapidly. But after the speed-up in growth of the force in the Fall of 1943, and after the beginning of attacks on enemy aircraft plants, the enemy rapidly lost out in the race for air supremacy. The steep drop in the percentage of bombers which were only hit by enemy fighters shows how rapidly they lost the power of anything like effective opposition to our bombing.

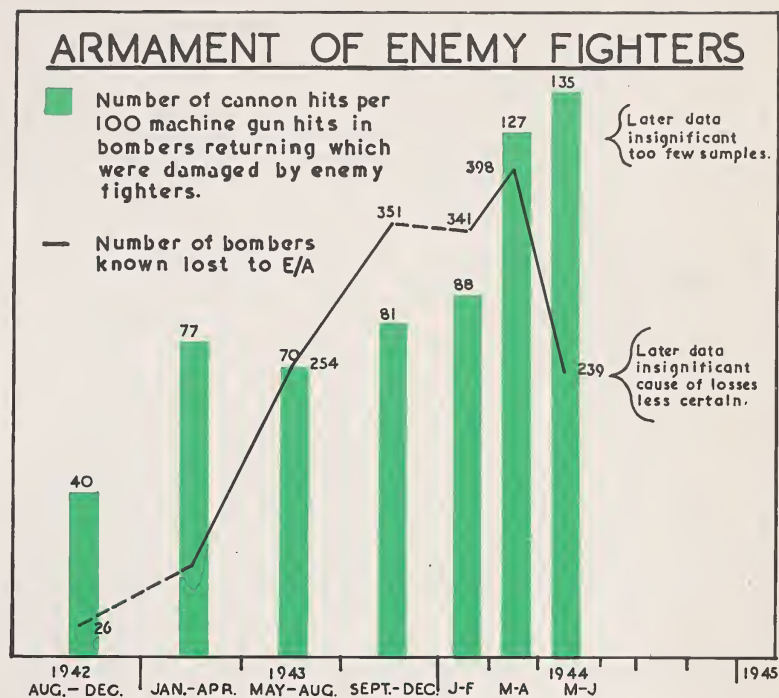


Chart B. Armament of Enemy Fighters

The rise in the number of cannon hits per 100 machine gun hits indicated that the enemy fighter force resorted to heavier and heavier armament in an attempt to halt the Eighth Air Force bombing attacks.

It is apparent that the number of bombers known to have been lost to enemy aircraft attack has some relationship to the percentage of cannon strikes on the bombers per 100 machine gun hits. That is to say, the enemy's policy of increasing the weight of his armament did result in destruction of a larger number of bombers. But, as pointed out in Chapter 5, Section 3, this increase of armament in continuation with several other factors, caused German Air Force fighters to become inferior in fighter against fighter combats.

Note: That the time-periods chosen in the chart were of varying lengths. The rate of change in armaments and losses therefore, is not shown in this chart.

3. CAPABILITIES OF THE AIR FORCES

(2) Lack of gasoline was a factor affecting the efficiency of the German Fighter Force. Fuel allotments for training schools continually were cut to supply first line units. Pilots posted to operational units often were prohibited from using gasoline for further training.

(3) Loss of experienced leaders was also an important factor. The change in the age level of pilots in 1941-1942 points to the fact that experienced leadership largely had been killed off. Effort was made to train new unit leaders in a course covering four to six weeks. The fact that none of these reached the prominence of Galland, Molders, Matoni and others, is an indication that such training was not adequate.

(a) War Experience of the German Air Force

Combat experience of German pilots at the beginning of the war was high, compared to other air forces. The Spanish Civil War had been used as a "proving ground" for equipment, and in the process, many pilots had received battle experience.

Further experience was gained rapidly in the early phases of the war. Campaign followed campaign, in Poland, Czechoslovakia, Austria, Norway, Holland, Belgium and France. Then came air battles in the Balkans, and the airborne invasion of Crete. Next followed the campaigns in Libya and Egypt with the Luftwaffe playing a major part.

On 22 June 1941, Hitler began his assault on Russia. This was a battle of great size over a huge and expanding territory. The Luftwaffe was disposed in great strength against the Russian Air Force. Half a year of large scale air warfare had taken place before America entered the war. Over a year of the Russian war passed before the Eighth Air Force made its first diminutive raid with 12 bombers on 17 August 1942.

All during this period, bombers of the Royal Air Force had been making attacks on German held territory and shipping.

The German Air Force possessed extensive battle experience, largely gained in air warfare of a tactical nature, by the time the Eighth Air Force began operations.

But the massing of huge formations and deployment for extended air battles with bombers having concentrated defensive firepower had not been experienced. The German still used the air weapon primarily as a tactical force in direct support of ground forces.

With the inception of daylight bombing by the Eighth Air Force, the enemy made no immediate effort to build up defensive strength on the Western Front. The invasion of North Africa by the Allied Forces had now forced Germany into ground battles on two fronts. The enemy placed a higher priority on these two fronts than on the threat which a growing bomber strength at British bases constituted, and he chose to deploy a large part of his air strength in direct support of these fronts.

When the Eighth Air Force began its bombing of targets in Occupied France, the German fighter pilot was a skilled and experienced fighter. Units like the "Abbeville Kids" will long be remembered as daring and aggressive opponents. But the tactical skill of German commanders did not match up with the abilities of their pilots. Attacks were made initially by small units when and where they could make interception. It took many months of air opposition to the Eighth's invasions before the German Air Force indicated a trend to concentrated attacks on single units of our force.

(c) The Enemy Fighter Control System

Early Enemy Fighter Control Methods: During 1942 German Day Fighters were concerned mainly with the defense of targets in Northern France, plus a few in Belgium and Holland. In order to defend these areas, a small geographic area was assigned to a particular fighter unit, and the unit operated within this geographic boundary. There was seldom, if ever, occasion for enemy fighters to make two sorties during one operation, and rarely any need for them to land away from base. The problem for the enemy was to get his fighters off early enough to secure a tactical advantage before the mission was over.

To aid the accomplishment of this, the coastal area was divided into five main day fighter units. Within these units were one or more day fighter controls, which were vested in a Jagdfluehrer (Jafu). Each Jafu had one or more

sectors from which the actual radio control of aircraft was carried on. Such radio control was based on information assembled in the sector headquarters from Radar, Observer Corps and intercept of Eighth Air Force Radio Traffic. For the most part the controller of the actual aircraft which had been dispatched limited his control to passing information concerning the height, composition, course and location of Allied aircraft. It was left to the air commander of the enemy unit to know where he was, and to make the best interception he could. Equipment and methods of control varied enough between sectors to make it impracticable for fighters under one control to pass to the control of another sector. This sort of control must be compared to the close vectors given by British ground controllers to their aircraft in the days of the Battle of Britain to realize how elementary the German system was.

Later Developments in Enemy Fighter Control

As the depth of penetration of the daylight heavy bomber effort increased and as the number of aircraft on the missions increased, the early method of German fighter control was found to be inadequate. The basic system using Radar detection, Observer Corps, and intercept of our Radio Traffic was not changed, but was merely extended to cover a larger area, and was increased in density of coverage to give more information. Larger areas were allotted to the existing Jafues; and additional Jafues were created in Southwest Germany, Austria, etcetera, where earlier there had been no organized fighter control system. In addition, high headquarters - Jagddivisions and Jagdkorps - became operational, in the sense that these began coordination of the work of the Jafues.

The control system finally came to be charged with the assembly of a large number of German aircraft in the air so that a coordinated attack, or series of attacks, could be delivered at the most opportune time. The rapidity with which fighters could be sent aloft was no longer the factor of supreme importance. Top priority went rather, to early evaluation of the whole operation, for the purpose of determining if any of the bomber forces was a feint, the probable depth of penetration, the probable target, the probable withdrawal route, the probable depth of fighter support, and other relevant details. To reach conclusions of this type, the German senior controller, probably located at Jagdkorps I headquarters near Berlin,

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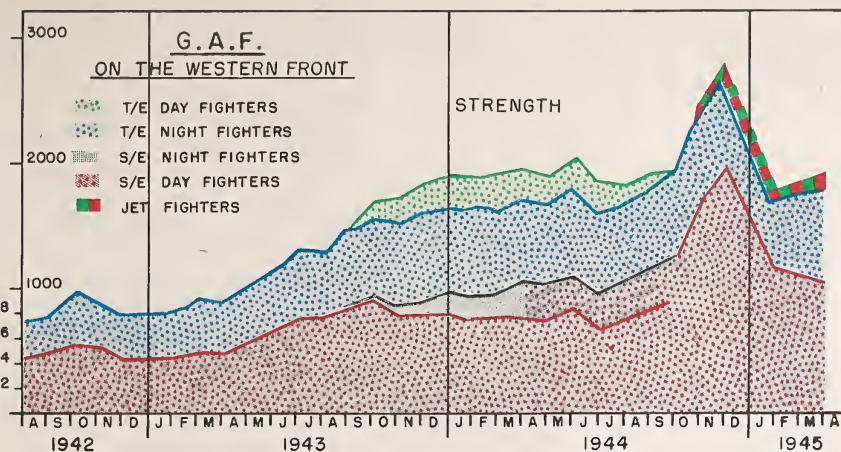


Chart A. German Air Force on the Western Front: Strength

German Air Force strength on the Western Front, as shown in this chart, was plotted from data prepared by Air Ministry. Rarely did the enemy react to our attacks in greater numbers than would have been anticipated from the disposition estimates.

Enemy twin-engine Day Fighters made their appearance and disappeared again within the space of a year. With the advent of long-range escort fighters, they quickly became obsolete.

Single-engine Night Fighters began to appear in the latter half of 1943. They absorbed all the increment to single-engine fighter strength for several months. But after April 1944, they were used increasingly for day fighting. In October 1944, they were officially labelled as straight day fighters.

Major Factors in Changes in Strength were (1) rate of loss; (2) rate of replacement; (3) movements to and from other fronts.

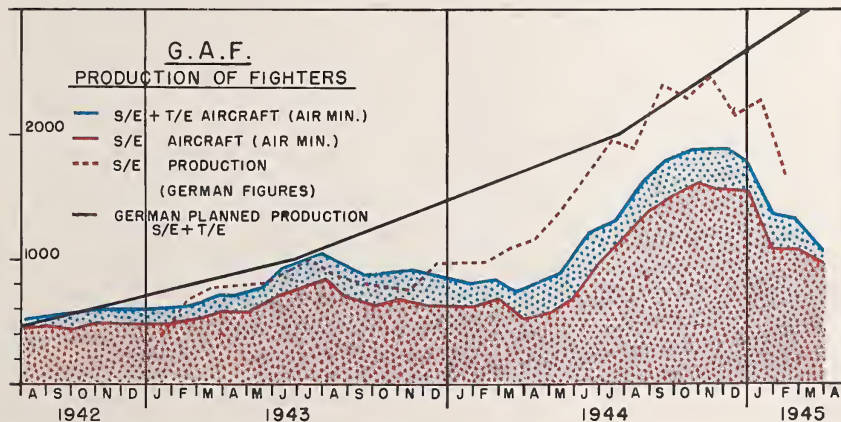


Chart B. German Air Force - Production of Fighters

Figures for the enemy production of single-engine and twin-engine fighters are British Air Ministry's estimates, made under limitations on accuracy imposed by war. These figures are believed to understate the fact.

Figures also are shown which were quoted in a letter from Speer, Reichsminister for Production, to Reichsführer Hitler. Until corroboratory evidence becomes available, these figures must be suspected of padding.

Single-engine fighter production probably was somewhere between the Air Ministry figures and the figures given by Speer.

Planned Production. There were many German plans for fighter production during the war, but one regarded by captured German experts as having been capable of attainment is shown to illustrate the effect on fighter production by Eighth Air Force bombing.

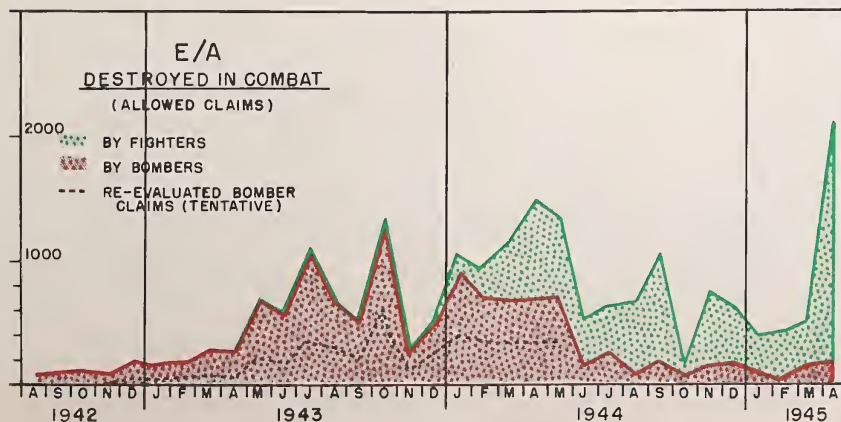


Chart C. Enemy Aircraft Destroyed in Combat

Bomber Claims: Though every effort was made to eliminate duplicate claims, the problem never was solved satisfactorily.

One estimate of a possible minimum of enemy aircraft destroyed by our bombers is shown as "re-evaluated claims."

Fighter Claims of enemy aircraft destroyed were added to the bomber claims. Hence, fighter claims alone are shown as the difference between the two solid lines.

Fighter claims are not subject to nearly as much error as bomber claims. Claim-evaluators have movie films of the fights to aid them. There may be some factor of error in fighter claims, but it is believed that fighter claims generally are close to the truth.

3. CAPABILITIES OF THE AIR FORCES

had the benefit of information from his lower echelons. This information was undoubtedly passed over land lines also, but a very considerable part of it was passed by radio to the senior control. In many cases it was consolidated and passed out again by radio as a "Running Commentary", to keep the fighters and all ground echelons informed of the progress of the operation.

As additional aid, to early evaluation, the German senior controller developed the use of spotter and observer aircraft, the sole function of which was to obtain visual contact with the Allied force and report by radio all pertinent data about it. Other factors which undoubtedly were of great assistance to timely interpretation of our operations were knowledge of weather over Germany, which allowed the German controller to limit the places to which the operation might go, the known target priorities of the Eighth Air Force and knowledge of usual approach and withdrawal routes.

With all this information and an added "feel" based on experience, the German Senior Controller made and executed his plans. Over the entire course of the air war, the effective range of the Eighth's fighter escort had a powerful influence on these defensive plans. Prior to mid-February 1944, when P-51s became operational, the main effort of German single-engine aircraft in the area west of the German border was to turn back escorting fighters, so that from the German border on to the target, the main defenses could go into operation. These defenses consisted of single-engine aircraft, as well as twin-engine day and night fighters. Emphasis clearly was on defense of the approaches to Central Germany, as opposed to defense of occupied territory. There was no great need for the twin-engine fighters to assemble with the single-engine fighters because the Eighth's escort which would have been lethal against the "twins" turned back at the German border. However, there was substantial need for single-engine coastal aircraft to assemble. To accomplish this coastal assembly a single coastal control frequently assembled, vectored and controlled a number of aircraft from different sectors of Jafues. To do this a single radio frequency for all German single-engine fighters came into use. This resulted in substantial increase in flexibility of control of these coastal based fighters and rapid reinforcement of one area by another.

When long range fighters of the Eighth Air Force began to go all the way to deep targets, the areas of close control, assembly and attack moved eastward. The defensive system was not radically changed, but the first line of defense by single-engine fighters was moved eastward to the Dummer Lake, Hamburg and Kiel areas. The attack staged by these fighters, (apparently on the initiative of the lower command echelon) was, for a limited period of time for the purpose of interfering with fighter escort as much as possible. Behind this single-engine assembly came the assembly of both single-engine and twin-engine fighters. Sectors, Jafues and Jagddivisions boundaries were disregarded. The whole effort of German control was to assemble two or more groups of aircraft along the bomber route to deliver mass attacks.

Close control for this type of operation was not essential. Good visual landmarks, and in some cases radio homing devices, were the elements necessary for the assemblies. Therefore, the Running Commentary which kept various echelons advised as to progress of the operation became the major source of information. When assembly was completed, German fighters were directed toward the bomber stream, and the effectiveness of subsequent attacks usually was related closely to how well the German Senior Controller had analyzed the bomber mission in advance. There was little chance to change the interception plan if the analysis was wrong. Likewise, the mass of German fighters had small need of highly accurate vectors or detailed directives of attack because the bomber stream was visible to them at a distance.

German controllers did manage from time to time to exploit unexpected Eighth Air Force errors such as a formation of bombers off course or lacking escort. It is evident, however, that the main concern of the enemy control system at this stage of the war was to assemble fighter aircraft in large formations which could deliver massive assaults on the bomber stream.

The end of this period came in the spring of 1944 when the German High Command realized that his twin-engine fighters were no longer an asset, because of their vulnerability to our fighters. For all practical purposes these "twins" became non-operational, except in areas east of Berlin and around Vienna.

During the final phase of the air war, just before and after invasion, when the Eighth's long range escort had developed to a point where full escort coverage could be given over the entire bomber route, the German fighter control adopted guerrilla tactics and occasionally achieved local superiority. Flights of German fighters were directed to distant locations for the purpose of concentrating one effective defensive striking force. No regard was paid to any boundaries. There was extensive use of a single operational radio frequency over the whole of Germany, and greater efficiency was developed in observing, shadowing and raid reporting. A wandering or unescorted bomber formation was quickly singled out, and made the objective of the largest force of enemy fighters possible. This pre-occupation with a single formation frequently resulted in the main bomber formation being unopposed. No additional control aids are known by which this type of interception was achieved. It seems to have been carried out through use in a more effective way of the regular control system and by a wider exchange of information between air observers, ground observers, radar and radio intercept operators and controllers.

(f) Enemy Pilot Morale

In 1942, the morale of German fighter pilots was very high. They were the elite of the German armed forces. Successful aces were highly publicized, and the Luftwaffe was lavish with decorations. The Luftwaffe had been more than a match for all-comers - with one exception: the Royal Air Force in the Battle of Britain.

That defeat must have perplexed the Luftwaffe sorely. The pilots had been told that the British had only a handful of fighters. Yet, whenever German raids took place over England, British fighters always made interception, guided by radar and aided by the highly effective use to which it was put by Royal Air Force fighter controllers.

By exploiting local concentrations against units disclosed by radar British fighters achieved decisive victories. And the British pilot shot down over his own territory usually would be up in another aircraft soon afterwards. The Battle of Britain shook the enemy.

But he still could maintain pilot morale. The German pilots felt that, should the air

(CONTINUED ON PAGE 104)

DISTRIBUTION of GERMAN FIGHTERS by FRONTS (Averages Within Indicated Periods)

No. of
Aircraft
2000

No. of
Aircraft
1200

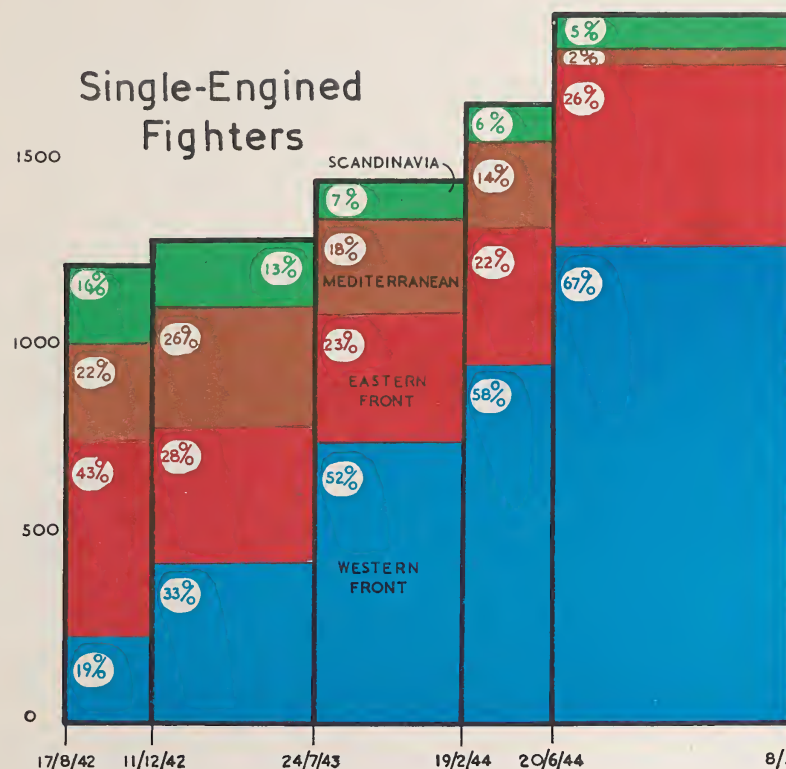


Chart A. Distribution of the German Air Force by Fronts - Single-Engine Fighters.

Average numbers and percentages during each of the five phases in the air war (see Chapter V, Section 4) are shown above.

The importance placed on the air war in the West by the German High Command is noteworthy. Both numbers of aircraft, and percentage of the total available single-engine fighter force, on the Western Front increased steadily to oppose the Eighth Air Force, and later, the Invasion.

Twin-Engine Fighters

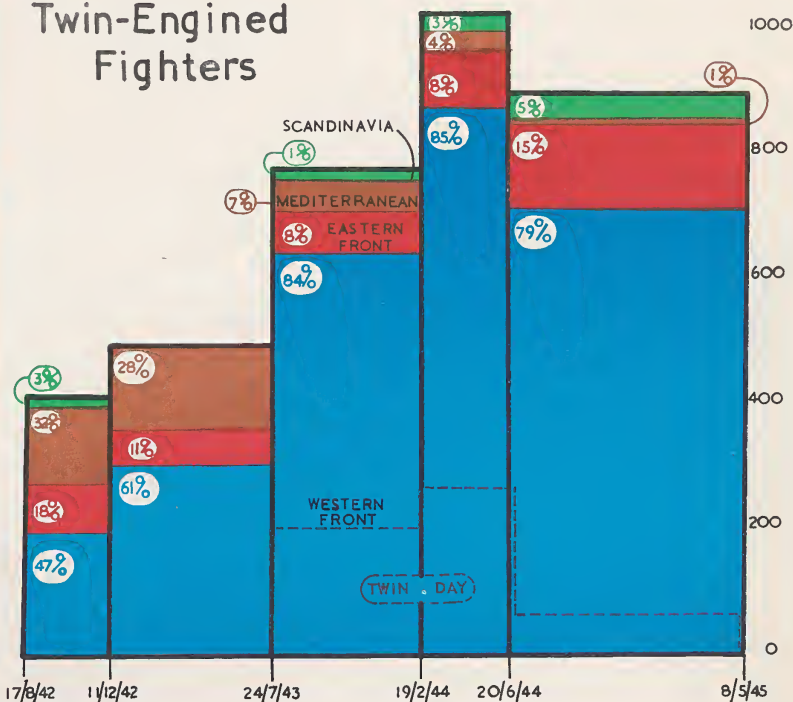


Chart B. Distribution of the German Air Force by Fronts - Twin-Engine Fighters.

The bulk of the enemy force of twin-engine fighters on the Western Front opposed the Royal Air Force. But as Eighth Air Force attacks became more serious in the Spring of 1943, the enemy used some twin-engine night fighters to oppose day as well as night attacks, and later set aside a number of twin-engine units to specialize in day fighting. In the third quarter of 1943, roughly 30 percent of the enemy's twin-engine force was assigned to day fighting.

Twin-engine day fighters with rocket-firing mortars constituted a force with high capabilities against our bombers, but the advent of long-range escort fighters ended this dangerous threat.

3. CAPABILITIES OF THE AIR FORCES

battle be fought over German territory, they would be invincible. When Eighth Air Force missions began German pilots, though shaken by the Battle of Britain, were supremely confident.

Many other factors acted to keep German pilot morale high. Unfavorable or unpleasant facts were kept from the pilots. Units moved from Front to Front often did not realize the true situation in the air war. Some undoubtedly became more vicious and fanatical because their homes were being destroyed by bombing. Food and off duty entertainment was good.

Probably the factor which surpassed all others in maintaining morale was the promise of super-weapons to come. The Allied fighters were securing current successes but German pilots were advised to wait until the new German jet and rocket propelled aircraft appeared. This faith in weapons of the future provides the most likely answer to the question of how could a force so badly out-classed and out-fought as the Luftwaffe possibly maintain the high morale which existed nearly to the end of the war. The pilot and even the high commanders had a mystic faith in the Fuehrer's ability to produce super weapons.

By the time that hope had collapsed, the end already was near.

It is worth noting that there were several negative influences on the morale of German pilots which had some effect, particularly near the end of the war. One by one, the highly publicized aces were killed. The successes of Allied air operations were observed directly by German Air Force pilots. Also, heavy losses in the individual unit could not be hidden.

There could be no "tour of duty" for the German pilot. Every pilot had to fight as long as he was alive and capable. Thus the shock of defeat was carried on. The depressing effect of heavy losses became cumulative. There was no relief to the pilots of the Luftwaffe except death or disability.

(g) Factors in Enemy Fighter Dispositions

The enemy day-fighter disposition in the west in August 1942 consisted of a modest size force spread along the Western coast of Europe from Norway to Brittany. There were several

reasons for its presence. One was to discourage daylight raids into Europe. Another was to protect coastal shipping from air attack. Patrols were necessary to watch for raids on the coast such as the Dieppe attack. And pilots must be familiar with the terrain in case invasion ever was attempted.

Strength at individual bases ranged from half a dozen fighters up to twenty. The original plan had been to have 3 Gruppen clustered on 3 adjoining airfields to form Geschwaders of about 100 fighters at intervals in the defense zone. But in allotting strength to the Western coast the German High Command had to consider the absence of ground operations, in the light of needs for air support in Africa and on the Eastern Front.

When Fortresses and Liberators, began to make daylight attacks the shallowness of penetration and the umbrella of short range escort initially demanded little increased defense by the Germans. A small fighter force could harass the bombers, and Spitfire cover could be avoided. The African campaign was claiming all spare enemy fighters.

In the spring of 1943, the enemy sensed the trend towards deeper penetrations by the Eighth Air Force into his territory. He developed a system of airfields which increased his capability of making second, or third, or even fourth sorties. Airfields were prepared and equipped with servicing facilities so that a German fighter pilot could break off combat anywhere with the certainty that he could find a landing. This defense-in-depth arrangement of airfields greatly increased operational capabilities.

As penetrations by the Eighth increased in depth, the enemy saw an opportunity to attack in force. Range of our escort was insufficient to allow it to accompany the bombers to targets of importance inside Germany. So the enemy built up his fighter disposition, and soon he developed tactics and armament which he believed would be an answer to any deep, unescorted bomber attacks. Auxiliary tanks observed on Eighth Air Force fighters were adopted by the enemy to give his fighters the range necessary to concentrate a large force from airfields widely dispersed.

In general, when attacks began against targets in an area or in a special category, enemy fighters were disposed so as to protect both the targets attacked and those against which attacks could be anticipated. The enemy built up his major defense between England and Germany's industrial areas and refused to defend much of France where no targets of vital importance existed.

By the summer of 1944, a shortage of technical ground personnel became apparent. A fourth staffel of 10 aircraft was added to each fighter Gruppe.

Toward the end of 1944, staffeln were increased in unit strength from 10 to 16 aircraft. Again this eased the shortage of ground personnel. Henceforth little change was made in unit organization until the end of the war.

One event badly upset the enemy's disposition pattern to oppose daylight bombing attack: the invasion of Normandy. When this took place the enemy attempted to concentrate most of his single-engine day-fighters in central France to aid his ground forces. The results obtained were meager, and losses were great. This tactical use of fighters effectively removed the Luftwaffe from effective intervention against bombers.

Finally, in an effort to counter Eighth Air Force attacks on oil, the enemy's fighter force was split with about half assigned to tactical employment, and the rest disposed deeply in Germany to oppose our bombers.

For the rest of the war, the Luftwaffe was torn between conflicting demands. Full strength was required in support of the German armies in the west. It was needed equally to support the Eastern Front. Anything less than the full force was inadequate to defend vital oil targets. To complicate his dilemma, the Royal Air Force turned to daylight bombing.

The final stages of the war as pointed out previously found the German High Command rushing units to the Western Front, to the Eastern Front, to deep defense, and back to the Western Front. If anything further had been needed to wreck effectiveness of the Luftwaffe, this rapid change of assignment did it.

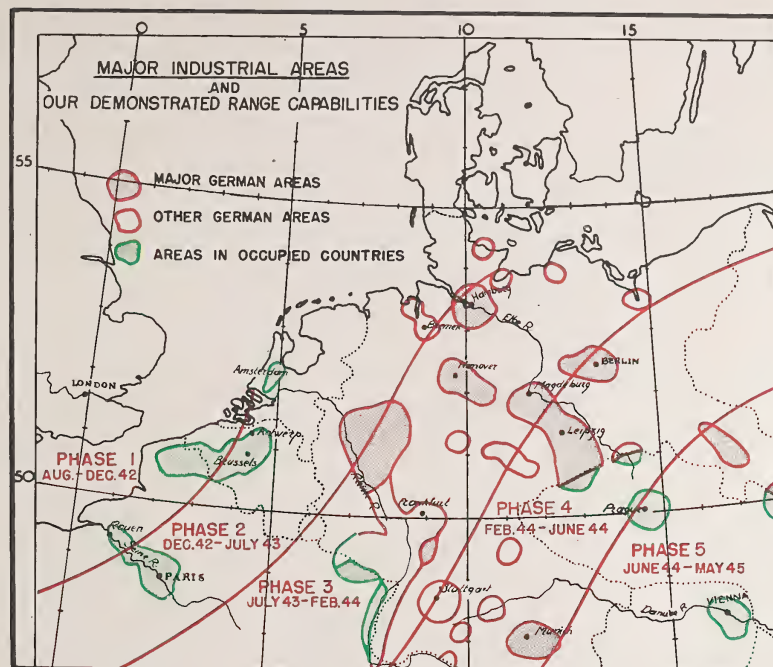


Chart A. Major Industrial Areas

Eighth Air Force bomber penetrations during the first phase of operations reached only a limited number of targets in important industrial areas of occupied countries and these were attacked only under conditions which did not endanger the population too greatly. In the second phase the great Ruhr District with its tremendous flak defenses and minor areas in Northwest Germany were reached. In the third phase attacks were begun on targets in areas critically important to German industry. The fourth phase found Eighth Air Force heavy bombers at last penetrating to the heart of German industry and economy. The fifth phase showed the Eighth Air Force's capability unrestricted: at last, bombs could be dropped anywhere in Germany.

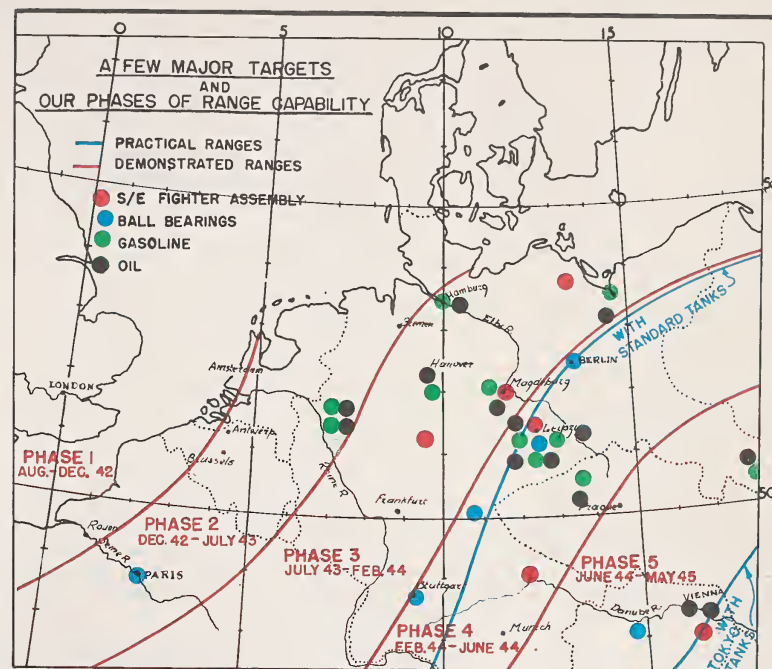


Chart B. A Few Major Targets.

All major targets plotted on this map, were targets of the Eighth Air Force with the exception of the area around Vienna.

This shows clearly that the industrial heart of Germany is centered around Leipzig, the focus of our attacks in the fourth phase, which began in February 1944.

4. STRATEGIC OPERATIONS-PHASE I. 17 AUGUST 1942 THROUGH 11 DECEMBER 1942

General Description: Bombing attacks by small formations of Eighth Air Force B-17s to the coastal area of the Continent typified this period. Top cover was supplied by very large numbers of Royal Air Force Spitfires, but on some shallow penetrations beyond the coast into occupied France and the Low Countries, the bombers ventured beyond range of this escort. Surprise was gained in certain cases through the use of radio countermeasures, fighter sweeps, and medium bomber attacks to "fix" or pin down the enemy defenses.

Enemy disposition extended along the coast line from Brest to Heligoland Bight with the bulk of the defenses in the Pas de Calais area and in front of Paris.

Enemy interceptions largely were local in nature. No reinforcement of the area under attack was attempted by the Luftwaffe until the

last mission of the period.

The enemy seemed uncertain as to the best tactics to use against the Eighth's formations, but he was moderately aggressive.

Type of Heavy Bomber Attack: Penetrations in this first phase generally did not exceed 50 miles into enemy territory. 84 percent of the attacks might be termed shallow with only 16 percent penetrating in depth into enemy defenses. Virtually all of the attacks went directly to the target, and withdrawals in general were reciprocal. Approximately two-thirds of the attacks were made by a single bomber force attacking one target. About one-third of the attacks hit two targets. Bomber losses in this phase were small.

Our attacking force averaged about 50 bombers flown in various formations shown in Chapter

I, under the appropriate dates. Escort was provided by between 400 and 500 Royal Air Force Spitfires, which gave high top cover to a point either just beyond the enemy coast, or short of it. Range of the Spitfires depended upon the length of the sea route and the accuracy of timing for the rendezvous with the bombers.

There were two areas of enemy attack: one between the Seine River and Amsterdam extending into the heart of enemy defenses, and the other from Brest to La Pallice.

The bombers employed certain measures to aid them in surprise and evasion. The two most important were "Moonshine", and medium bomber attacks accompanied by fighter sweeps. "Moonshine" was a radio countermeasure used by a small force of Royal Air Force Defiants to make the force appear to German controllers as a large heavy bomber formation. The Defiants
(CONTINUED ON PAGE 108)

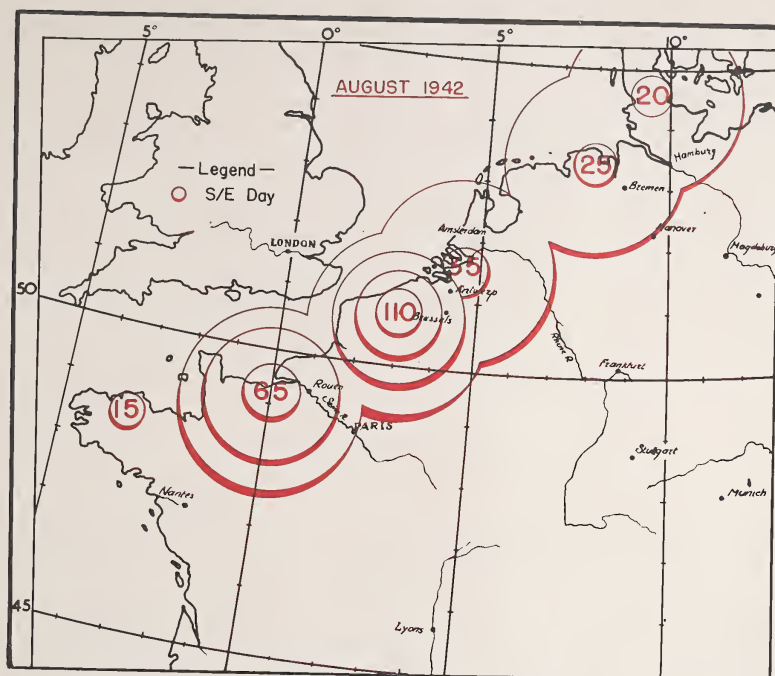


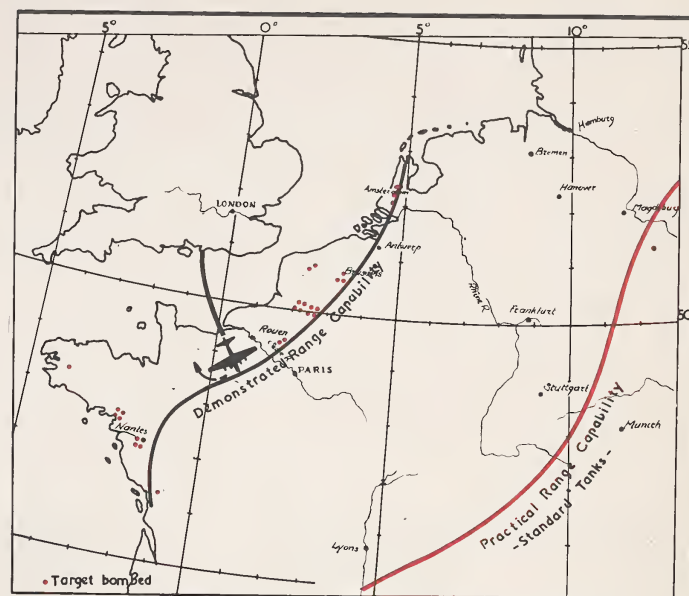
Chart A. Enemy Single-Engine Fighter Disposition

Beginning the First Phase of the Air War

The large circles shown above represent a 100 mile radius around a center of disposition. This radius was the approximate maximum distance for interception during the First Phase of the Air War.

The maximum concentration of strength in disposition then was in the Pas de Calais area of France. A second focus of defensive disposition was in Normandy. Both defended among other things, the routes to Paris. The rest of the coast of France, the Low Countries, and Northwest Germany had sparse defenses.

For the enemy disposition at the end of this period, resulting from attacks, turn to Chart A, page 111.



FIRST PHASE - 17 Aug. 1942 - 11 Dec. 1942

Chart B. First Phase

The range capability which bombers of the Eighth Air Force demonstrated to the enemy during this phase of the Air War, is shown as a black line roughly paralleling the coast of France. The major targets attacked are shown as red dots. Thus, the areas of our attacks were generally, the Pas de Calais; the Atlantic Coast of France from Brest southward; and the vicinity of Rotterdam, Holland.

The depth of penetration was limited, not by range of the bombers, but by the limited endurance of escort fighters. This was a period of trying out equipment, developing techniques, and gaining battle experience.

4. STRATEGIC OPERATIONS - PHASE I. 17 AUGUST 1942 THROUGH 11 DECEMBER 1942

flew out over the North Sea or the Channel but returned to England without reaching the enemy coast to prevent the enemy from realizing exactly what it was he mistook for heavy bombers.

Medium bomber raids were timed to engage enemy fighters sufficiently in a specific area to "fix" them and thereby prevent or delay attacks by these fighters on heavy bombers. Fighter sweeps either with or without medium bomber attacks, were successful at first in attracting the attention of a considerable number of enemy fighters.

Three other measures of evasion were used to a less extent. Feints by the heavy bombers were flown on 27 percent of the missions; "fixing" attacks by heavy bombers 18 percent; and routes indicating alternative objectives for the actual target were flown 5 percent of the time.

Type of Enemy Reaction: Because of "Moonshine" and other "fixing" operations during this early period, the enemy's interception was almost entirely local. That is, aircraft attacking the bomber force, were based within approximately 70 miles of penetration and withdrawal routes. Individual enemy units would continue the attack for 80 to 110 miles along the route.

Enemy attacks were made on the average along approximately two-thirds of the total penetration and withdrawal across enemy territory.

As there was no fighter reinforcement by the enemy of the area under attack, no secondary defenses were involved. This was the case both because of shallow bomber penetration, and because of the lack of deeper enemy disposition.

The enemy reacted strongly to evasion

methods, particularly during the early part of the period. Reaction to "Moonshine", fighter sweeps, and medium bomber attacks was strong. "Moonshine" worked well until November 1942. Thereafter it decreased somewhat in spite of the fact that the enemy never did understand what caused the effects of "Moonshine". Toward the latter part of the period the enemy attempted to concentrate on the heavy bombers which he now was beginning to identify.

Feints throughout this period by the heavy bombers continued to draw strong reaction. Due to weakness of the enemy's warning services, he resorted to air alerts. The reason for this was that only shallow penetrations were being made and German warning services were unable to estimate types or numbers of aircraft with any accuracy.

A strong reaction usually resulted whenever heavy bomber "fixing" attacks were employed. Small forces of heavy bombers under escort pinned down disproportionately large numbers of enemy interceptors.

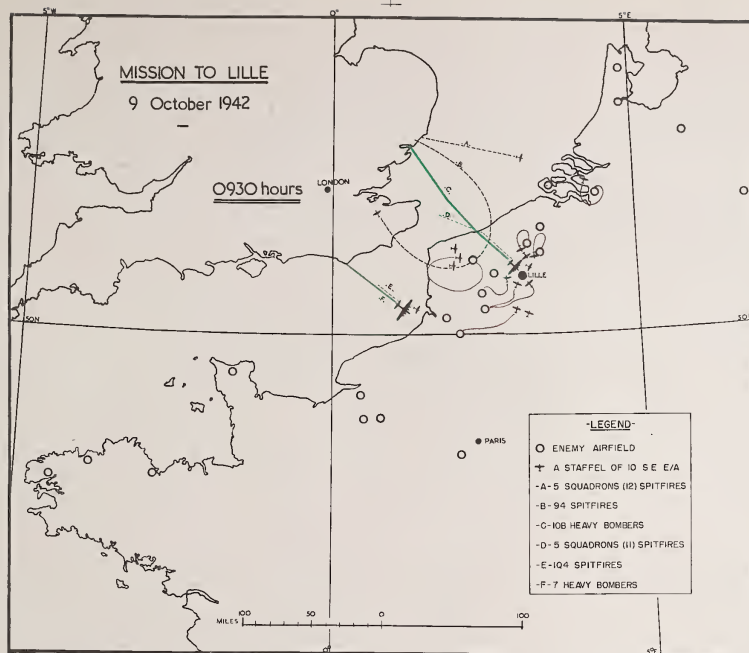


Chart A. Mission to Lille - 9 October, 1942

Penetration. The main attack of 108 Eighth Air Force bombers with 10 squadrons of Spitfire escort was made with a straight route from Orfordness to the target, preceded by a fighter sweep by 94 Spitfires over the Pas de Calais. A fixing attack was carried out by 7 B-17s with Spitfire escort toward Abbeville, and a Spitfire sweep toward the Dutch Islands was intended to divert other enemy fighters.

The 94 Spitfires were first over the enemy coast. Twenty plus enemy fighters came up, but no encounters ensued. As our main force of bombers crossed over St. Omer on the way to the target, attacks by 80 plus enemy single-engine fighters began.

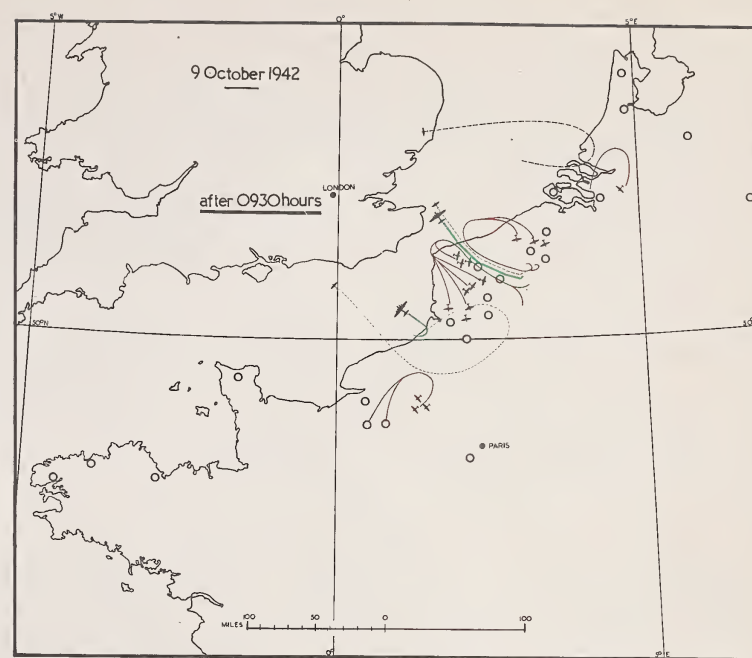


Chart B.

Withdrawal. The enemy fighter attack on the main bomber force grew in intensity toward the target. 66 B-17s bombed the Lille marshalling yards and steel plants under visual bombing conditions, and with fair to poor results. Four bombers were lost, 40 damaged, and one escort fighter was shot down.

Our fixing attack at Abbeville, by 7 B-17s and escort was pursued by 30 plus enemy fighters, but no contact was made. The fighter feint toward the Dutch Islands brought up 10 plus enemy fighters without contact.

Bomber claims of enemy aircraft destroyed, probably destroyed and damaged were 25-38-44, while our fighters claimed 5-3-1.

5. STRATEGIC OPERATIONS-PHASE 2.
12 DECEMBER 1942 THROUGH 24 JULY 1943

General Description: This period opened with the first Eighth Air Force attack on the Romilly airfield and storage depot on 12 December 1942 and ended when an attack on Rostock, on 25 July 1943, began a new phase. It represented an extension of the Eighth Air Force's demonstrated depth of penetration to approximately 160 miles of enemy territory as compared to approximately 50 miles in the first period. This addition was the result of the increased size of the bomber force and of the formations flown which gave some improvement in defensive fire. There was no increase in escort range, armament or any other defensive factor. Enemy disposition had changed little by the beginning of the period but by the period's end in July 1943, there had been a considerable build-up chiefly in Holland and Northwest Germany of

enemy defensive fighters. Some secondary defense was added in the vicinity of Stuttgart.

Bomber Formations: The bomber formations flown during this phase continued the trend towards compressing many bombers into smaller and smaller air-space. When the phase began on 12 December 1942, the Eighth Air Force was flying a javelin of four groups of 18 aircraft each, (see pages 12, 13 and 14). The groups had a tendency to string out because of the increasing altitude of each successive group. When a fifth group finally was added, this tendency was seriously amplified. A new formation was needed.

By February 1943, the lead group has been placed at mid-altitude, echelonning up to one side and down to the other (see pages 15, 16

and 17). This reduced the speed differential between the lead group and the one at the end. This group wedge was flown only a few times before it was discovered that, under fighter attack, the other groups tended to close in on the lead as much as possible. Five groups, tightly closed, made an unwieldy mass of aircraft. So it was decided to capitalize on this defensive maneuver and fly only three groups close together for defensive fire protection. This was called a Combat Wing.

The 54 aircraft Combat Wing, (see pages 18, 19 and 20), as first flown in March - April 1943, was too wide. By the end of April, a similar formation had been devised, (see pages 21, 22, 23 and 24), with each Squadron compressed by overlapping the element: the Group com-

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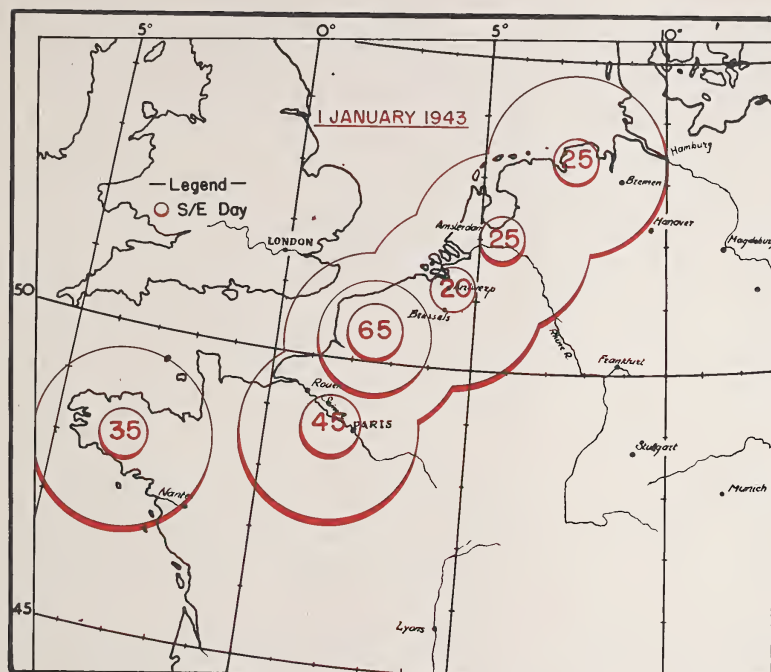


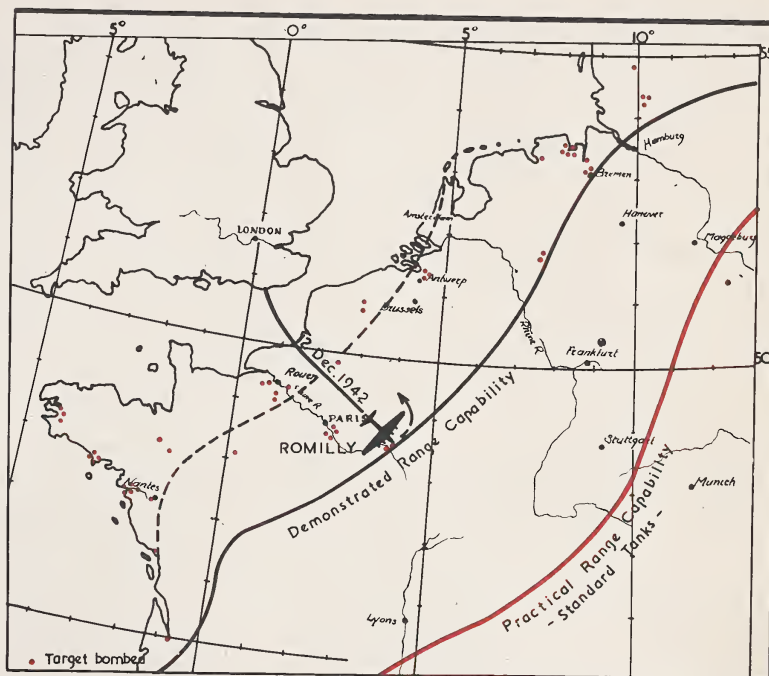
Chart A. Enemy Single-Engine Fighter Disposition

Beginning the Second Phase of the Air War

Little change is to be noted in enemy fighter disposition from August 1942 except for the fact that the total was reduced from 270 to 215. The only local increase of note was the addition of 20 on Brest Peninsula.

The African Campaign was now in full swing. It is probable that additions to enemy disposition on the Western Front were delayed for this reason.

Disposition for the end of this second phase is shown in Chart A, page 119.



SECOND PHASE

12 Dec. 1942 24 July 1943

Chart B. Second Phase

Major target areas of the Eighth Air Force were now Northwest Germany around Bremen and Kiel; the Atlantic Coast of France from Brest southward; and the Seine River area up to Paris.

Approximately half of the penetrations still were into the first area of demonstrated penetration. The chief new areas under attack were: the submarine facilities on the Northwest German Coast; the vicinity of Antwerp; and Paris.

5. STRATEGIC OPERATIONS - PHASE 2.
12 DECEMBER 1942 THROUGH 24 JULY 1943

pressed by overlapping the Squadrons; and the Combat Wing was compressed by overlapping the Groups. The width of the Combat Wing thus was cut to about half its original dimensions.

Escort Tactics: By May 1943, United States P-47s began to join the Royal Air Force in providing escort. These fighters began by flying a tight top cover - the Royal Air Force "umbrella". But before long, however, P-47 pilots began to drop down and engage the enemy fighters. Their range of escort was similar to the Spitfire - about 170 miles from bases or only a short way into enemy territory. This was the period of trying out the equipment and gaining experience.

In June 1943 the P-47s began a process

which was to continue throughout the Air War. They began to open out somewhat - up to 100 yards or so between each fighter aircraft to add to flexibility and thereby increase the number of guns which could be brought to bear on the enemy.

Throughout the war, as Eighth Air Force bomber formations became more compact, the escort flew more and more widely until it became a huge net to envelop the enemy.

During this period enemy targets mainly in three areas were attacked. One area was the heart of the enemy's defenses in France, the second the area of German U-boat bases along the Atlantic coast and the third the area of U-boat facilities in Northwest Germany around Heligoland Bight.

By this time the enemy had become much more aggressive. He was reinforcing the areas under attack, and his fighters were following Eighth Air Force bombers far out to sea on withdrawal. Penetration depth of the Eighth Air Force was insufficient to permit the enemy to inflict serious losses when the bombers were without escort.

Type of Heavy Bomber Attack: The depth of penetration into the enemy fighter defenses still was shallow on 42 percent of the missions in this period, and of medium depth 58 percent of the time. 59 percent of the penetrations went directly to the target and 77 percent of withdrawals were reciprocal or direct. By now the Eighth Air Force was attacking more than one target 70 percent of the time and by indirect

(CONTINUED ON PAGE 114)

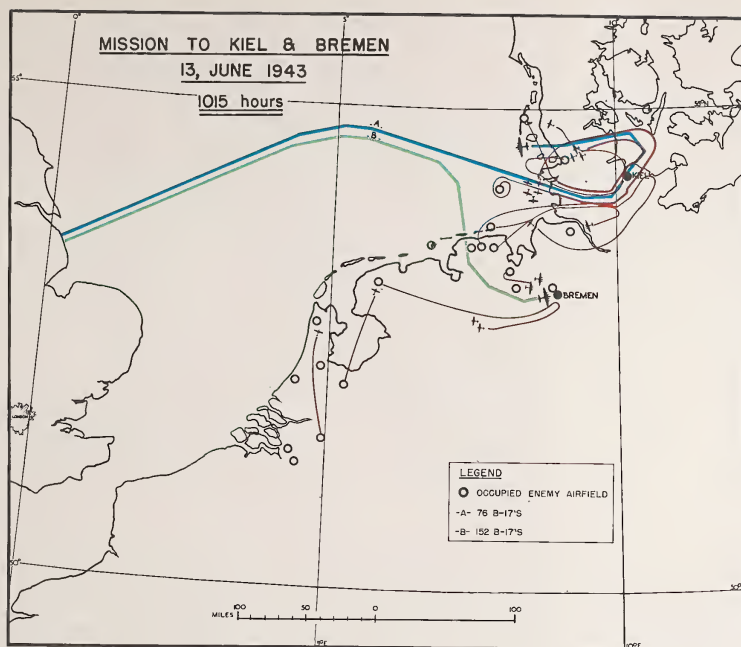


Chart A. Mission of 13 June 1943 to Kiel and Bremen

Penetration. On 13 June 1943, two forces of bombers were dispatched over the North Sea to attack targets in Northwest Germany. 76 bombers of the 4th Bomb Wing were dispatched to attack the U-boat construction yards at Kiel. 152 bombers of the 1st Bomb Wing were dispatched to attack similar targets at Bremen. Cloud and visibility conditions were excellent at both targets. No escort could be provided as yet for such a distance.

It was anticipated that enemy interception capabilities at Bremen could be very severe. In an effort to assist the bombers going to Bremen, the escort flew a half hour to the rear of the Kiel force.

As the Kiel formation passed over the Danish coast, it was attacked by an interception force of 110 or more single-engine enemy fighters. Attacks were made in formations of from 2 to 6 in line. The enemy concentrated on the leading groups of bombers. His fighters came in from all angles and took advantage of the sun and clouds to obtain surprise. Attacks chiefly were aimed at the nose of the bombers.

Some twin-engine enemy fighters remained out of range firing cannon shells into our formations. There were at least two air-to-air bombings by enemy fighters, one of which destroyed a bomber.

The Bremen force was shielded on the way to the target by its position behind the Kiel raiders. No enemy attacks occurred before the bombers reached their target.

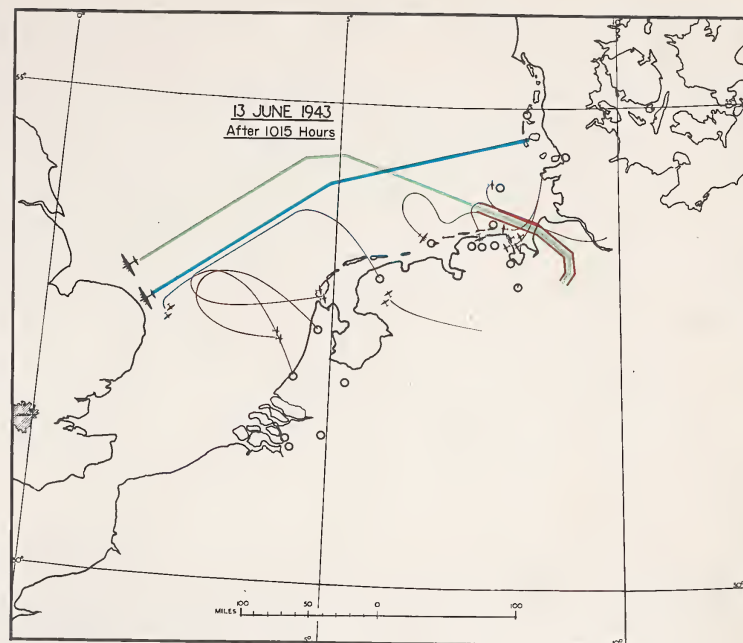


Chart B.

Withdrawal. Severe attacks on the Kiel force continued until it withdrew over the Danish coast.

The bombers attacking Bremen meanwhile were under light attack by a mixed force of single- and twin-engine fighters which followed the bombers for some distance out to sea. The Bremen raiders withdrew well to the North.

The force which bombed Kiel withdrew to the South and East of the Bremen force. Single-engine enemy fighters based in Holland now flew far out over the North Sea to attack the Kiel force. Combats continued virtually to the English coast.

The Kiel raiders lost 22 out of 76 bombers or 34 percent. This was far the greatest percentage loss to date. The Bremen force lost 4, for a total loss of 26. Enemy fighters accounted for 21 bombers, flak for 2, and 3 bombers were lost to other causes.

Claims of enemy fighters destroyed, probably destroyed, and damaged were 39-5-14 by the Kiel force, and 2-2-1 by the Bremen force.

Bombing at Kiel was hampered seriously by the severity of the enemy attack. At Bremen, an effective smoke screen lowered effectiveness of the bombing.

5. STRATEGIC OPERATIONS - PHASE 2.
12 DECEMBER 1942 THROUGH 24 JULY 1943

route penetrations was attempting to confuse the enemy as to the objective 41 percent of the time.

Tactics of surprise and evasion were used. On 32 percent of the missions routes were chosen with the primary objective of confusing the enemy concerning which important target was to be attacked. On 30 percent of the missions the heavy bombers made feints intended to use up flying time of the enemy fighters or distract them from the real targets.

Fourteen percent of our missions in the period resorted to medium bomber attacks and fighter sweeps. "Fixing" attacks also were employed on 14 percent of the missions.

Enemy Disposition and Type of Reaction:
Enemy fighter disposition at the start of the

period was much as it had been in August 1942. It still consisted of a shallow coastal defense from Brest to Heligoland Bight, weighted heavily in the Pas de Calais area. German Air Order of Battle in the coastal area dropped from 270 single-engine fighters in August 1942 to 215 in January 1943.

During the second phase, Eighth Air Force attacks resulted in an increase to 515 enemy fighters in the coastal area, with a secondary defense of 60 single-engine enemy fighters in the Munich-Stuttgart area. Enemy disposition was spread fairly evenly along the coast, with some weakening in the southwest toward the Brest Peninsula.

Reaction differed in the three large areas of attack. For instance, in Northwest

Germany, bomber penetration of enemy territory was not great, although the bombers flew a long route over the North Sea. In that area enemy fighters sometimes came distances of 110 to 130 miles to the attack.

To defend targets in the Brest Peninsula and along the Atlantic Coast of France, German fighter aircraft would fly 90 to 110 miles to attack during the Eighth Air Force's first 100 miles of penetration and from as far as 190 miles to attack during the second 100 miles.

Penetrations towards the center of the enemy defenses would attract enemy fighters as far away as 120 miles from the bomber route on occasions when the Eighth Air Force penetrated

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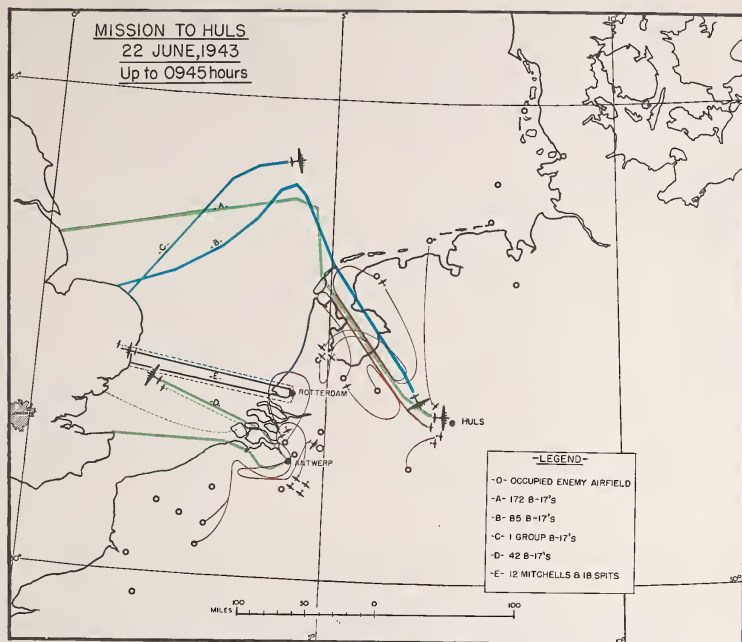


Chart A. Mission of 22 June, 1943 - Huls.

Penetration. On 22 June, 1943, 257 B-17s of the 1st and 4th Bomb Wings, were dispatched to attack the synthetic rubber factory at Huls. Fighter support could be provided for withdrawal only, and therefore various other measures were taken to divert enemy fighters. A fixing attack was planned against the Ford Motor plant at Antwerp by 42 bombers of the 1st Bomb Wing, with 8 squadrons of P-47s for escort. Twelve Mitchells with Spitfire escort were to bomb Rotterdam, and a diversion was to be flown by one group of B-17s over the North Sea.

Enemy fighters expected to oppose these attacks consisted of 110 single-engine fighters based in Holland and 130 single-engine fighters in the Pas de Calais area. Some twin-engine fighters could be expected.

As the main force flew southeastward over the Dutch Islands toward Huls, the Mitchells struck at Rotterdam and the B-17s at Antwerp. Some 20 interceptors were vectored toward the Mitchells but no contact was made. The same fighters then attempted interception of the Antwerp bombers, but were forced to land through shortage of fuel.

Some 70 single-engine and 8 twin-engine fighters attacked the Antwerp force which did not effect rendezvous with the P-47s until Antwerp had been passed.

Meanwhile, the main bomber force was attacked upon crossing the enemy coast. 60 or more single-engine fighters engaged part way to the target. An additional 30 attacked the leading bombers just before they reached Huls.

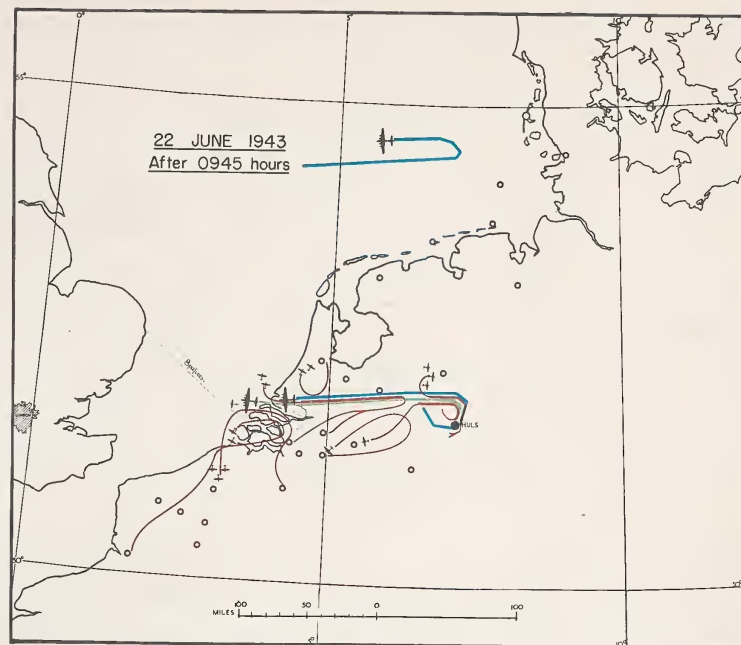


Chart B.

Withdrawal. After bombing, the main force experienced attacks all the way to the coast on withdrawal. Fighters from the Pas de Calais, some on second sortie, attacked the 1st Bomb Wing which was about 2 miles ahead of the 4th Bomb Wing. As the coast was neared, 23 squadrons of Spitfires and 3 squadrons of Typhoons joined the bombers as escort. Attacks decreased sharply thereafter and ended at the coast.

Bombing results by 170 bombers attacking at Huls were good, 39 attacking at Antwerp gave fair bombing results. The bombers claimed enemy fighters as destroyed, probably destroyed, or damaged to the extent of 47-23-44. Escorting fighters claimed 2 probable and 1 damaged.

Our bomber losses totalled 20, 14 to enemy fighters, 5 to flak, and 1 to cause unknown. One escort fighter was lost.

5. STRATEGIC OPERATIONS-PHASE 2.
12 DECEMBER 1942 THROUGH 24 JULY 1943

more than 100 miles.

Center attacks and penetrations around Brest Peninsula would attract enemy fighters from distances of 160 to 170 miles during withdrawal.

But in all areas, the enemy attack was "piecemeal". Each enemy unit attacked when and where it could. On withdrawal the bombers sometimes were under attack all the way across the North Sea to the coast of England.

Individual attacks by enemy units in all three areas usually would persist for distances of 170 to 190 miles along a route. The entire route in enemy territory was under attack by one or more enemy units during penetrations into northwest Germany or the center of the

French defenses. The enemy's interception during this period was very aggressive; he attacked fighters as well as bombers.

The enemy still lacked secondary disposition until the end of this phase. He got somewhat the same result by providing temporary reinforcement for the local fighters in an area of attack. Reinforcement units would land and refuel after coming into the Brest Peninsula from distances as great as 250 miles; into Northwest Germany from 210 miles away; and into the center of the enemy disposition around Paris and the Pas de Calais from a distance of 170 miles.

Enemy reaction to measures of evasion also varied. In the central area there was strong reaction to most "fixing" attacks,

fighter sweeps and medium bomber attacks. Feints began to lose the ability to draw enemy fighters, as bomber penetrations deepened and the enemy began to realize the futility of air alerts. However, he still reacted strongly to about half of the feints.

In the Brest Peninsula area he continued to react to two-thirds of the "fixing" attacks, but reacted only to one-third of the feints, medium bomber attacks or fighter sweeps.

In Northwest Germany, because Eighth Air Force targets were at distances then too great for fighter escort to reach, measures of evasion were difficult. Feints by unescorted bombers began to receive too vigorous attacks and had to be discontinued.

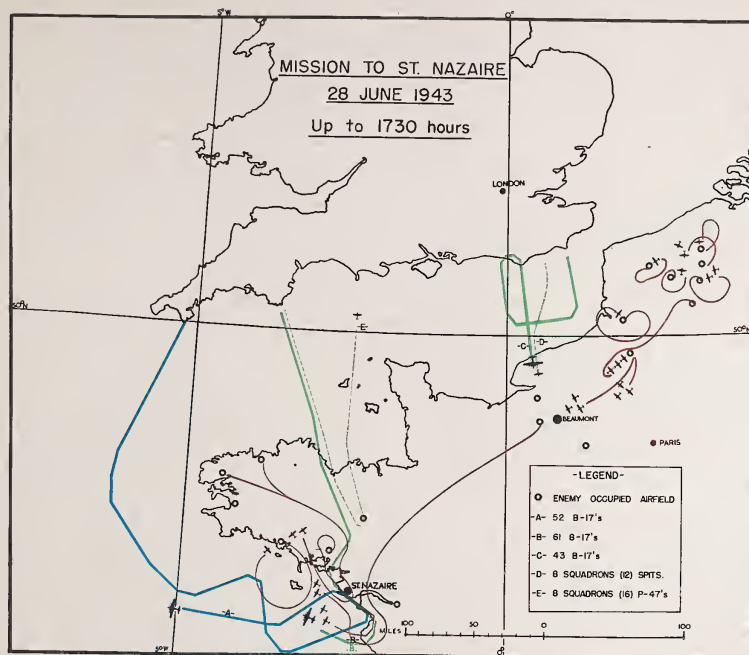


Chart A. Mission of 28 June, 1943 to St. Nazaire

Penetration. The main attacks were against the St. Nazaire locks. 104 bombers of the 1st Bomb Wing (120 dispatched) had a route to the target across Brittany, and 54 bombers of the 4th Bomb Wing (71 dispatched) flew far out into the Atlantic around Brest Peninsula to attack from the direction of the sea. These 4th Wing bombers were using the long-range wing tanks (Tokyo tanks) for the first time. Both forces made feints toward Lorient to confuse the enemy regarding the target to be attacked. The 1st Wing was escorted about 40 miles beyond the coast of Brittany by 83 Squadrons of P-47s.

Meanwhile 50 B-17s of the 1st Wing made a feint toward Amiens, south of the Pas de Calais, with the intention of arousing enemy fighters in the Beaumont area and preventing them from flying southwestward to reinforce fighters defending against our main attacks at St. Nazaire. After the feint, these 50 B-17s circled back to the English coast and then bore directly down toward the airfield at Beaumont-le-Roger. Enemy fighters in the Pas de Calais area were air-alerted by the feint but, in general, turned back to their bases as the bombers turned away from the French coast back toward England. About 20 enemy fighters left Beaumont-le-Roger flying toward St. Nazaire.

The 1st Bomb Wing was not attacked while crossing Brittany under escort, but as the escort turned back, the bombers were engaged by some 50 enemy fighters from Brest Peninsula which were later reinforced by the 20 from Beaumont.

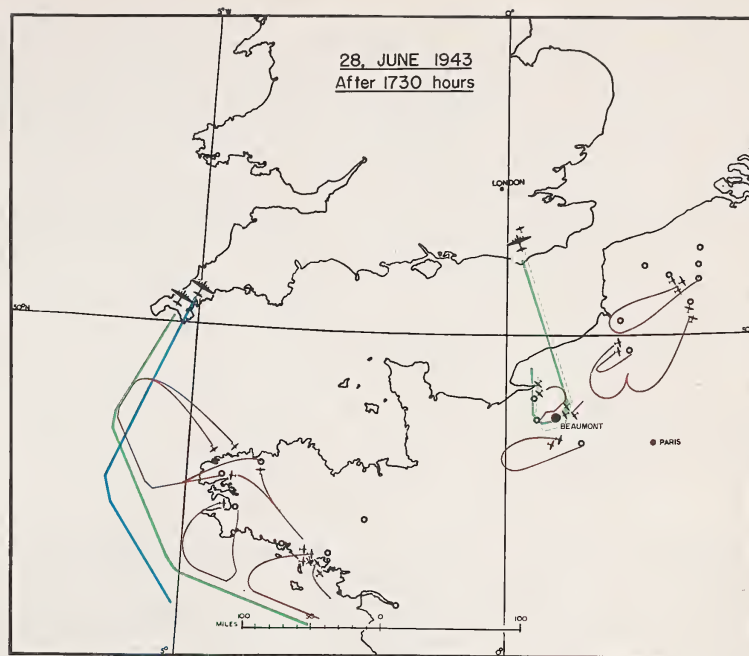


Chart B.

Withdrawal. The 1st Bomb Wing was under attack continuously as it bombed the target and headed out to sea. Enemy fighters dropped four aerial bombs in salvo at the formation and made attacks upon the nose and tail of the formation in groups of two or three up to eight fighters.

The 4th Bomb Wing, coming in from the sea to attack and withdrawing out to sea, was virtually unnoticed by the enemy.

As the two Wings withdrew, the 1st Bomb Wing flying the course nearest the Continent was attacked by about 30 enemy fighters far out to sea. These attacks continued half way to Lands End. The enemy fighters probably were on second sortie.

The attack on Beaumont successfully prevented most of the enemy fighters in that area from reinforcing the defenders at St. Nazaire. The enemy in the Pas de Calais area and around Beaumont had been "put off balance" to the extent that only 40 of his fighters made interception. Most of these were handled by the escort.

Bombing results at both targets were good. The enemy's defensive measures, apparently confused by our feints and thrusts destroyed only 8 bombers of the 1st Bomb Wing. Our claims of enemy aircraft destroyed, probably destroyed and damaged were 28-6-8.

6. STRATEGIC OPERATIONS-PHASE 3.
25 JULY 1943 THROUGH 19 FEBRUARY 1944

General Description: On 25 July 1943, an attack was made by Eighth Air Force heavy bombers on a target at Rostock in North Germany, thus initiating a new phase in the depth of penetrations to which the Eighth was prepared to extend operations. This phase ended when the attacks of 20 February 1944, on targets near Leipzig, began the fourth phase.

The limits of the penetrations for this third phase were demonstrated on the 17 August 1943, when one force, equipped with Tokyo tanks, thrust deep into Germany to attack the Messerschmidt Aircraft Plant at Regensburg, and withdrew southward over the Alps to North Africa. A few hours later a second force of B-17s with standard tanks, flew to Schweinfurt to attack the ball bearing plant there and then withdrew westward to England. The first force demonstrated a capability of attacking anything in

Southwest Germany, all of France, and most of Italy, by withdrawing to North Africa.

Bomber Formations: The bomber formation flown for most of this period was the more compact 54 aircraft Combat Wing. A Task Force consisted of a column of such Combat Wings in trail, (see pages 21, 22, 23 and 24).

In January 1944, a new formation came into use (see pages 25, 26 and 27). The 54 aircraft Combat Wing had had too little flexibility. Its three groups of 18 aircraft each had been tied closely together, and the handling of so many aircraft as a unit was difficult.

Now, the individual group was doubled in strength to 36 aircraft. It was still composed of three squadrons, lead, high and low, with the wing squadrons echeloned either side of the line of flight. But the individual squadron now

was composed of four flat elements of three aircraft, the elements stacked as a lead, high, low and a low-low.

Combat Wings now lost much of their identity as units. In such a formation there was a four mile interval between the lead and number one group, and another four mile interval between the number one and number two groups. The two groups following after the lead were staggered slightly to opposite sides of the line of flight.

The Combat Wing following left an interval of four miles. The lead group of the next Combat Wing flew in the trail of the lead group of the previous Combat Wing.

The Group formation presented a compact defensive fire for the defense of its 36 air-

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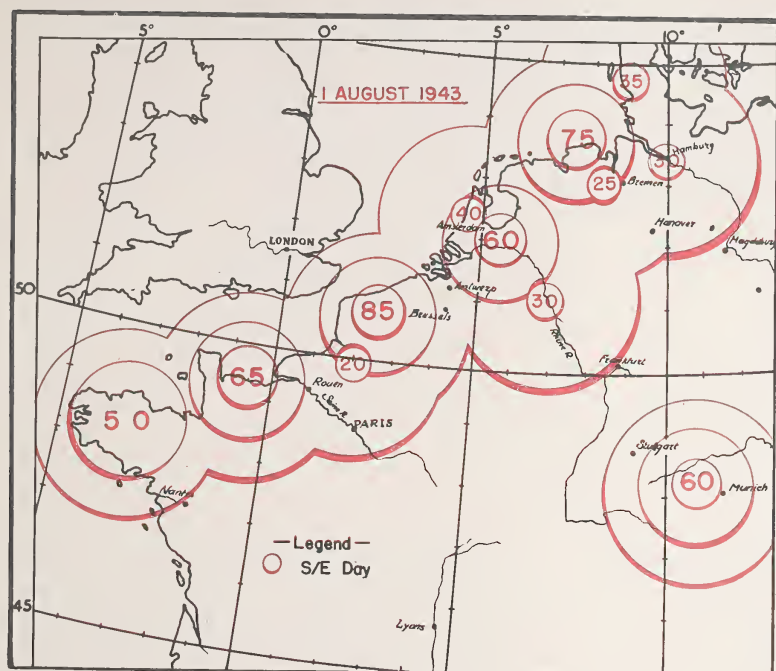
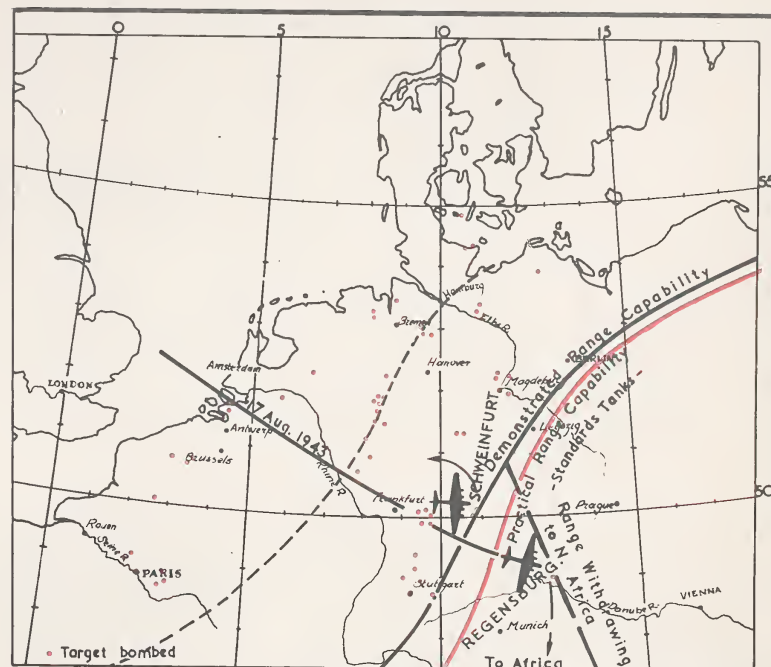


Chart A. Enemy Single-Engine Fighter Disposition 1 August 1943

Beginning the Third Phase of the Air War

A strong increase in single-engine fighter disposition will be noted. The defenses from the Pas de Calais northward had been augmented, particularly in Holland and Northwest Germany. The first disposition "in depth" was made between Stuttgart and Munich. (This depth defense was unsuspected until mid-September; but its presence early in August is obvious from the nature of enemy reactions to missions in this area).



THIRD PHASE

25 July, 1943 - 19 Feb., 1944

Chart B. Third Phase

The previously demonstrated range of the Eighth Air Force was exceeded 25 July 1943 in the attack on Rostock. The maximum depth of direct penetration and withdrawal to England for this phase was reached in the attack on Schweinfurt, 17 August 1943. On the same day, another force, equipped with Tokyo tanks, attacked deep in Southwest Germany at Regensburg and withdrew to Africa. The delay in getting this force back to England prevented repetition of this route. This range was not exceeded until 20 February 1944.

The major target areas now were (1) Northwest German ports; (2) the vicinity of Hamm and Munster, North of the Ruhr; (3) Hanover-Brunswick; (4) Frankfurt-Schweinfurt; and (5) Paris.

Escort ranges increased slightly in the early part of this phase, but began a major extension in January 1944.

6. STRATEGIC OPERATIONS-PHASE 3.
25 JULY 1943 THROUGH 19 FEBRUARY 1944

craft. Limiting this unit to 36 instead of 54 aircraft added considerably to flexibility.

Escort Tactics during this Period: The processes of "opening out" the fighter formation continued throughout this period. Late in July 1943, the first belly-tanks became available for the P-47s, and made possible some tactical surprises. The enemy had been in the habit of forming up just beyond range of escort with his twin-engined fighters. On several occasions following the sudden addition to range, Eighth Air Force fighters were able to fly straight into an enemy formation, score many victories and thereby disrupt the attack on our bombers.

By September 1943, the Eighth Air Force fighters began to get useful aid from the British "Y" Service. Trained radio operators

translated intercepted messages from German controllers and passed on this information for immediate operational use. This enabled our fighters to attack enemy assembly areas, throw enemy concentrations off balance and disrupt the enemy's plan of bomber interception.

When both German and Eighth Air Force fighters were within range of British Type 16 control, this control directed the Eighth's fighters to a position of advantage. It was a radar device similar to Micro Early Warning but of shorter range, which allowed a fighter controller to observe on a screen the relative positions of friendly and enemy fighters.

In January 1944, the basic conception of the use of fighter escort changed. The earlier order, "protect the bombers" was expanded by adding "and pursue and destroy the enemy". Now, some of the escort remained in constant defense

of the bombers while others intercepted enemy attacks on bomber formations and then pursued enemy fighters wherever they fled. Fighters leaving escort were permitted to "sweep the deck". This added a powerful new force to the attack on German troops, transport, and communications.

Toward the end of the period, the Eighth's fighter escort groups spread out to 25 or 30 miles in width, so that it was difficult either for the enemy in the air or his warning services on the ground to detect them. One squadron would sweep well ahead of the bombers while the other two squadrons of the group swept at the sides of the bomber formation.

Enemy Disposition: From August 1943 through February 1944, there was little change in the number of single-engine enemy day

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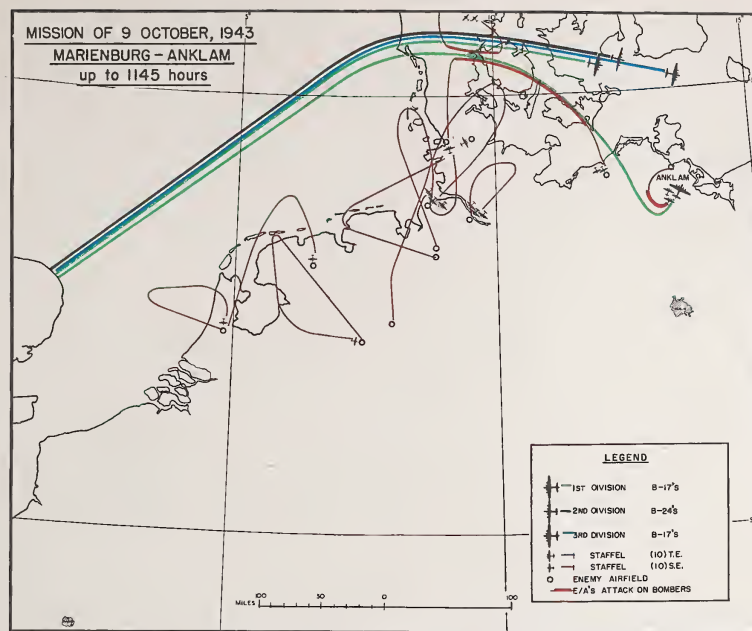


Chart A. Mission to Marienburg, 9 October 1943

Penetration. Six combat wings of B-17s and B-24s were sent far North over the Danish Peninsula to attack distant aircraft and naval targets in East Prussia and Poland at Marienburg, Danzig and Gdynia. Such range was possible because of the low altitude and route assembly which gained perhaps two hours of flying time compared to direct penetrations. Two other combat wings, flying on a route somewhat to the South were to bomb the Focke Wulf aircraft plant at Anklam, and withdraw on a reciprocal route. By engaging much of the enemy the Anklam attackers would aid both penetration and withdrawal of the forces going deeper. Escort could not be provided except for part of the withdrawal over the North Sea. Enemy disposition included 135 single-engine day fighters in Northwest Germany and Denmark with an additional 135 in Holland as potential reinforcement. 40 single-engine night fighters were within interception distance of the routes. 80 twin-engine day fighters were now in Northern Germany.

As the first bombers started out over the North Sea, the enemy, confused by our "carpet" radar countermeasures, sent out scouting forces to report on the bombers. None of these made contact. Our first force was engaged by local defenders over Denmark. Again near Anklam single-engine and twin-engine fighters attacked. Many enemy fighters, disposed in Northwest Germany, started Northward but failed to "follow through"

The task forces headed for East Prussia followed the Anklam force, across Denmark and the Baltic to their targets without interception.

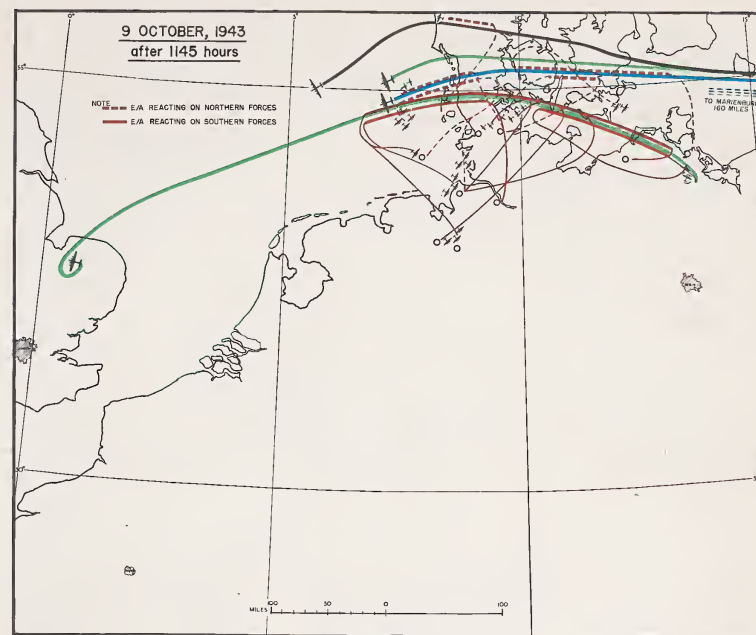


Chart B.

Withdrawal. The Anklam force sustained severe attack all the way from the target well beyond the coast of Denmark. Some 80 single-engine and 90 twin-engine fighters intercepted, making vigorous attacks. Air-to-air bombing and rocket-firing from the twin-engine fighters, combined with more orthodox attacks, accounted for 18 bombers lost from this force. The escort, planned for part of the withdrawal, failed to make rendezvous because the bombers were ahead of schedule.

The main force, after bombing an aircraft plant at Marienburg and naval installations and warships at Gdynia and Danzig, was opposed by some 30 single-engine and 30 twin-engine fighters, while withdrawing beyond Denmark. These attacks were not vigorous since the enemy fighters were on their second or third sortie. The B-24s flown to the North evaded all but a short fight with about 10 single-engine enemy fighters.

Bombing results at Anklam were very good, and excellent at Marienburg. Good results were obtained at Gdynia but little was accomplished at Danzig, due largely to heavy smoke screens at these two ports.

Total bomber losses were 28, enemy fighters accounting for 19; flak 3, and other reasons 6.

Claims of enemy fighters destroyed were 122, probably destroyed 29, and damaged 61.

6. STRATEGIC OPERATIONS - PHASE 3.
25 JULY 1943 THROUGH 19 FEBRUARY 1944

fighters disposed against the Eighth Air Force. The increase which did take place built up a single-engine night fighter force to a strength about 25 percent of day fighters.

A very serious enemy threat came from a new day fighter which grew to considerable proportions during this period - the twin-engine rocket-firing fighter. During this phase, such fighters became roughly one-third as numerous as single-engine day fighters. Because of its long range, the "twin" was a constant menace. It appeared from distant airfields in opposition regardless of which route the bombers took.

German Air Force fighter disposition changed during the period from essentially a coastal defense, to a defense behind the Rhine. Small forces were left for defense of probable invasion areas. But the bulk of the German Air

Force was disposed just west of the great industrial areas in Germany with secondary defenses as far back as Berlin.

This change was a result largely of the destructive effect which Eighth Air Force long range fighters began to have on German interceptors, particularly toward the end of the period. The provision of fighter defense in the area of the Eighth's early penetration of enemy territory became too costly for the Luft waffe, and a disposition of fighters on the ground exposed to our fighter escort "sweeping the deck" on the route home proved too vulnerable.

Depth of Penetration and Areas of Attack:
The attack at Schweinfurt involved a direct penetration into enemy territory of 320 miles and withdrawal to England. This depth of penetration was not to be exceeded until

February 1944. It employed almost the full range capability of the B-17 with standard tanks for a direct penetration. Requirements for effecting formation and gaining initial altitude before reaching the coast line were the limiting factors.

During this third phase there were three major areas of attack and two minor ones. The major areas were, Northwest Germany, Western Germany and Northern France and the Low Countries. A few attacks were made against targets on the Atlantic coast around Bordeaux and a few more were made in Northern Germany.

During most of this period, fighter escort of the Eighth Air Force was capable of penetrating beyond the enemy coast to distances up to 160 miles. The penetration of the bombers, however, went beyond this. To reduce the time

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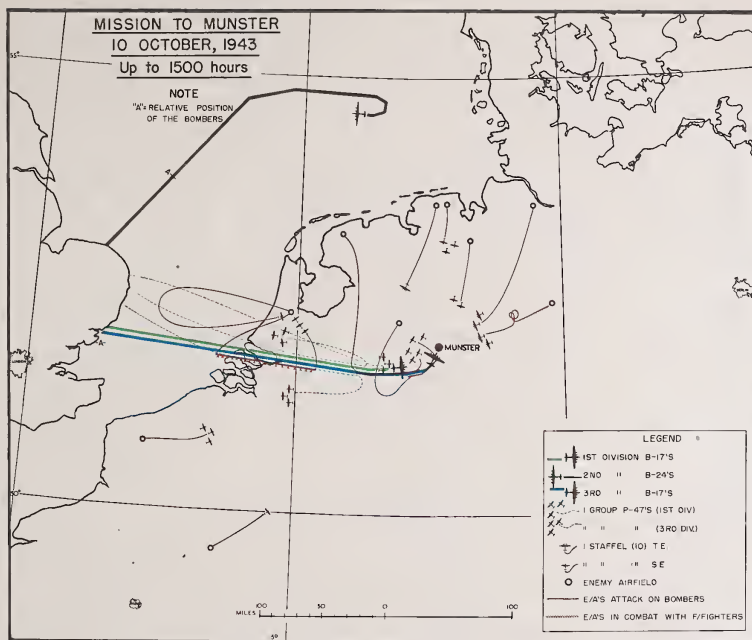


Chart A. Mission to Munster, 10 October 1943.

274 B-17s of the 1st and 3rd Divisions were dispatched on a direct route to bomb the railway and waterway junctions at Munster. They were escorted to a new depth of penetration by P-47s. The 3rd Division, in the lead, was out of escort for about 30 minutes, during which time concentrated enemy attacks destroyed 29 bombers. The 1st Division, following closely, was escorted for the entire route, having one group of P-47s with it in the target area. The escorted force was largely avoided by the enemy, which destroyed only one bomber.

Enemy fighters were disposed 135 single-engine in Holland, 100 single-engine and 80 twin-engine in Northwest Germany. A further disposition to the Southwest came Northward in redeployment and would have been available for interception on a deeper penetration by our bombers.

As our bombers left England, enemy aircraft flew out to scout the force. Fighters from Holland continued to scout as the 3rd Division crossed the coast line and headed for Munster. After the escort left the 3rd Division near the Rhine, the enemy began concentrated attacks on the nose of the leading groups with units of 2 and 3 attacking the low bombers in the formation. Fighters headed toward the battle area both from the South, and from the North where controllers had learned that the B-24s, making a feint over the North Sea, comprised only a small force. Cannon shells and rocket fire came from the twin-engine fighters. One group of 12 bombers was destroyed in this attack.

The 1st Division proceeded to the target with few enemy attacks en route.

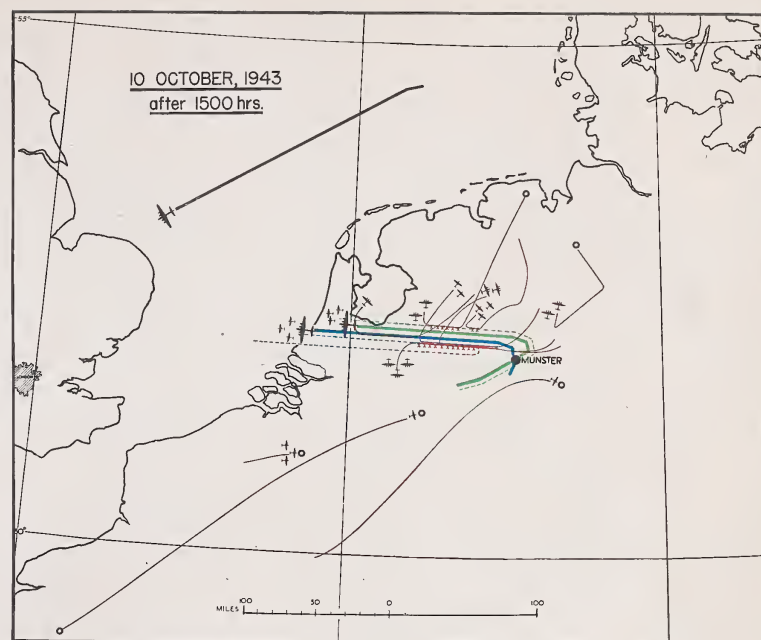


Chart B. Mission to Munster, 10 October 1943.

After bombing, the 3rd Division withdrew straight toward England still under heavy attack. Arrival of P-47 escort fighters soon drew most of the enemy's attention.

The 1st Division reached the target with a single group of P-47s which had, thereby, set up a new record for depth of escort penetration.

Enemy fighters were flying Northwestward from the Beaumont area in expectation of a deeper penetration on our part. The fight ended during withdrawal toward the Dutch coast.

Bombing of Munster was good in spite of the violence of the enemy defense. 236 bombers attacked targets out of 284 dispatched. 216 escort fighter sorties were flown. Total claims for enemy aircraft destroyed, probably destroyed, and damaged were 204-22-55, out of which fighters claimed 21-1-4 and bombers claimed 183-21-51. Bombers lost were: 3rd Division - 29; 1st Division - 1. 1 fighter was lost.

This mission demonstrated the great value of a fighter escort force. It now was apparent that heavy losses would be sustained when penetrations were made beyond escort range into an area where the enemy could concentrate his fighter defenses.

6. STRATEGIC OPERATIONS-PHASE 3.
25 JULY 1943 THROUGH 19 FEBRUARY 1944

of exposure beyond the range of escort, attacks usually went straight to the targets and back. These deep bomber penetrations beyond fighter escort range represented a bold attempt by the Eighth Air Force to establish that heavily-armed bombers could fly deep into enemy territory with only the protection of their own defensive fire-power. The losses on some of these missions tended to prove the opposite, if the bombers were opposed by an alert and desperate enemy.

The enemy at this time was exceedingly aggressive and quick to grasp the plan of Eighth Air Force operations. He developed methods of concentration, new armament and improved tactics which made deep daylight bombing penetrations beyond escort too costly to be continued.

Type of Heavy Bomber Attacks: During phase three, 81 percent of Eighth Air Force penetra-

tions were direct and 86 percent of withdrawals were direct or reciprocal. By this time the bomber force was large enough so that 81 percent of the time more than one target was attacked per mission. Depth of penetration was sufficient for routes to be chosen suggesting alternative objectives 22 percent of the time.

Penetrations were very deep 7 percent of the time, deep 18 percent, medium deep 52 percent and shallow 23 percent.

Type of Enemy Reaction: The bulk of our bombing missions penetrated to the center of enemy defenses. On penetration, enemy fighters intercepted from distances as great as 160 miles from the route on penetration and as great as 220 miles on withdrawal. Attacks by individual units of enemy fighters extended as far as 180 miles along the route. Bomber forces were under attack 60 to 100 percent of the whole route on these center penetrations.

Many withdrawals, out over the North Sea or the Channel, were attacked. In one instance enemy fighters followed the bombers back over Kent.

On these central attacks reinforcement areas of enemy defense extended as far as 200 miles from a bomber route. Both single-engine and twin-engine fighters were disposed in secondary defense. The "twins" rapidly learned to avoid areas where bombers were under escort.

Routes from Northwest Germany were intercepted from distances as great as 130 miles, both on penetrations and withdrawal. As penetrations in this area did not go so deep into enemy territory, and because of the long North Sea route, attacks by individual enemy units never exceeded 110 miles of the route. But the entire route in this area was under attack while over enemy territory, and frequently withdrawals over the North Sea were under attack almost to the shores of England.

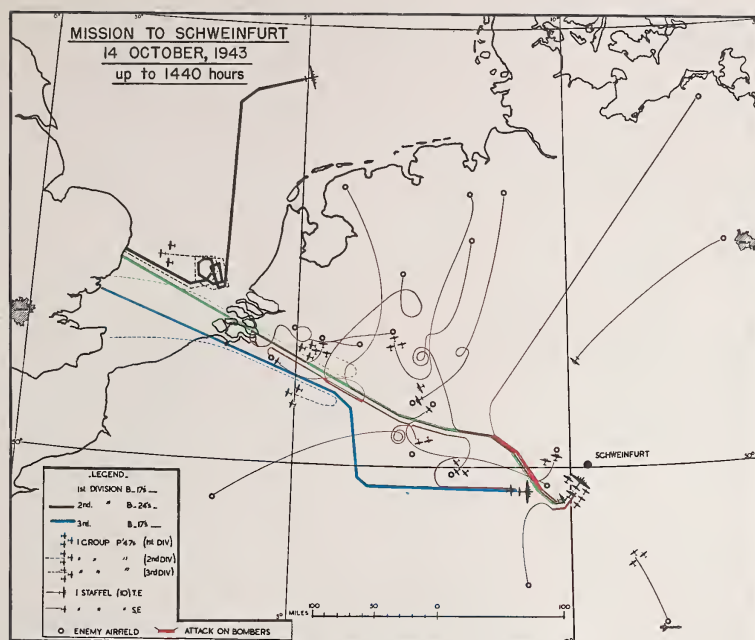


Chart A. Mission of 14 October, 1943 - Schweinfurt

Penetration. Two formations each of approximately 150 B-17s flew parallel courses to the Dutch Islands where P-47 escort met them. 47 B-24s were supposed to follow the leading B-17 formation, but, unable to rendezvous with their escort because of weather conditions, the B-24s flew a diversion route over the North Sea.

The fighter escort accompanied the bombers to Aachen. Contrary to recent custom, enemy attacks concentrated on the escort. Upon withdrawal of the P-47s the enemy launched a concentrated attack with single-engine and twin-engine fighters which had congregated in the area from fields as distant as Bremen and Laon down near Paris. Single-engine fighters would single out a group of bombers and make nose attacks, singly or in twos or threes. Twin-engine fighters flew in formations astern of a bomber formation and fired salvos of rockets from distances of approximately 1,000 yards.

At the point of departure of the escort, the 3rd Division turned South for about 70 miles and then East toward the target. This split route had the effect of concentrating most of the fight on the 1st Division which continued to fly directly toward the target.

The split route and a sharp turn by both Divisions to a North-northeast heading for the bomb run somewhat confused the enemy with the result that attacks diminished during the run.

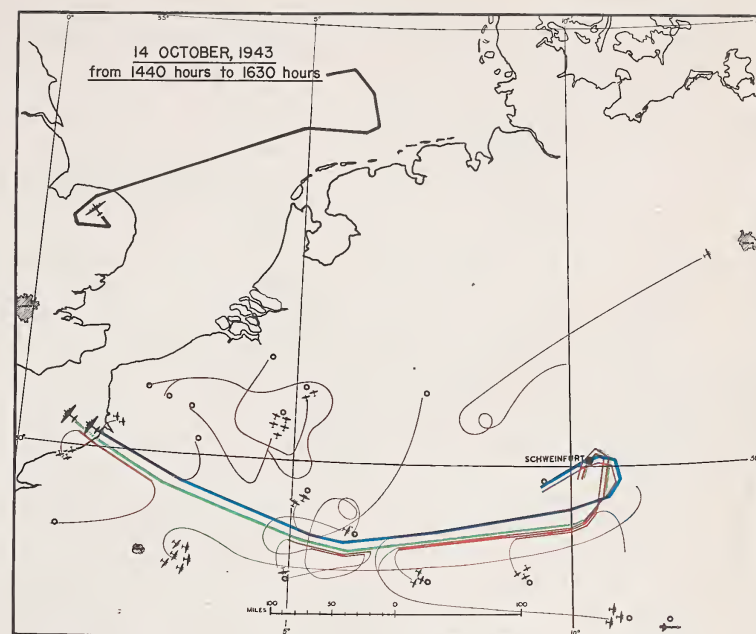


Chart B.

Withdrawal. The enemy now had airborne some 200 single-engine and about 120 twin-engine fighters, 50 of which were rocket-firing. The weight of the attack became very severe as the bombers turned nearly 270 degrees to the right for withdrawal. Most of the 60 bombers lost were shot down during this turn.

As the two Divisions began to withdraw westward, they ran into bad weather. The bomber formations became extended. The combination of bad weather and less cohesive formations turned out to be an advantage to the Eighth Air Force because about 60 twin-engine rocket-firing aircraft, which intended to intercept soon after the target, were not able to make contact.

Few bombers were lost to attacks during the withdrawal.

The bombing at Schweinfurt had been good in spite of vicious enemy interception. 60 bombers were lost, 45 out of the 1st Division. Claims of enemy aircraft destroyed, probably destroyed and damaged totalled 199-28-94; the bombers claiming 186-27-89, and the escort fighters 13-1-5.

Although the enemy still was committing his fighters in small assault units, this mission emphasized a trend toward massive concentrations.

7. STRATEGIC OPERATIONS—PHASE 4. 20 FEBRUARY 1944 THROUGH 20 JUNE 1944

The new phase began with a highly important mission by the Eighth Air Force to Leipzig, beyond the old demonstrated range. The full limits of the new range capability were not demonstrated, however, until an attack was made on targets at Munich on 19 March 1944. This indicated to the enemy a capability of penetrating his territory to a distance of approximately 450 miles made possible by the addition of large numbers of long-range escort fighters. This depth of penetration was not to be exceeded until 21 June 1944.

Bomber Formations: Throughout this phase, the same formation was flown as at the end of the third phase: the 36 aircraft Group, and the Combat Wing of 3 Groups at 4 mile intervals in trail with the Wing Groups stepped one to each side of the line of flight (see pages 25, 26 and 27).

Escort Tactics: A new factor of the utmost importance now had entered the air war, the long range escort fighter began to appear in increasing numbers. Instead of evading the enemy, the aim now was to provoke attack and to force enemy fighters into combat which the Eighth Air Force could stand but which the Luftwaffe could not.

The escorting fighter groups continued to

spread out 25 to 30 miles in width and frequently a squadron or a group was sent to sweep the route directly ahead of the bomber formation.

Increasing use was made of groups on a "free sweep". They would fly deep into enemy territory toward an area of expected enemy assembly, there break down into flights and "throw out a net" to enmesh the enemy fighters. Eighth Air Force fighter pilots were becoming increasingly aggressive. Frequently, a flight of four would charge into an assembly of 50 to 100 of the enemy, break up this formation and destroy a considerable number for little or no loss.

Sometimes the enemy would not come up to fight. Then our sweeping fighters would go "down to the deck", strafe airfields, flak towers, railroad trains and other suitable military targets.

Our Tactics of Attack: At the beginning of this period, attacks were made simultaneously on many targets with decisive effect. The mission of 20 February 1944, during which enemy controllers and fighter pilots became thoroughly confused, brought to the enemy a realization of the true capabilities of a great bomber-fighter force.

For the first part of the period indirect penetrations were used to a great extent, but as the Eighth Air Force's new long range fighter force increased and its pilots became increasingly aggressive, routes became more and more direct. Over the whole period 62 percent of penetrations were direct and 72 percent of withdrawals were direct or reciprocal. Almost every mission involved multiple targets.

The area of attack now had become "all of Germany". A few missions included formations destined for Poland. With such deep penetrations the opportunity of flying routes affording alternative objectives was greatly increased, with a result that 52 percent of missions were flown in this manner.

Fighter sweeps were no longer evasive in purpose. On 51 percent of the missions in this period, fighter sweeps were made deep into enemy territory to search out the enemy, break up his assembly, and force him into combat.

Enemy Disposition: A violent change in enemy disposition took place near the end of this period. The enemy had thrown a cordon across the routes to his industrial heart area. He had moved 68 percent of his single-engine fighters to the Western Front to stop daylight

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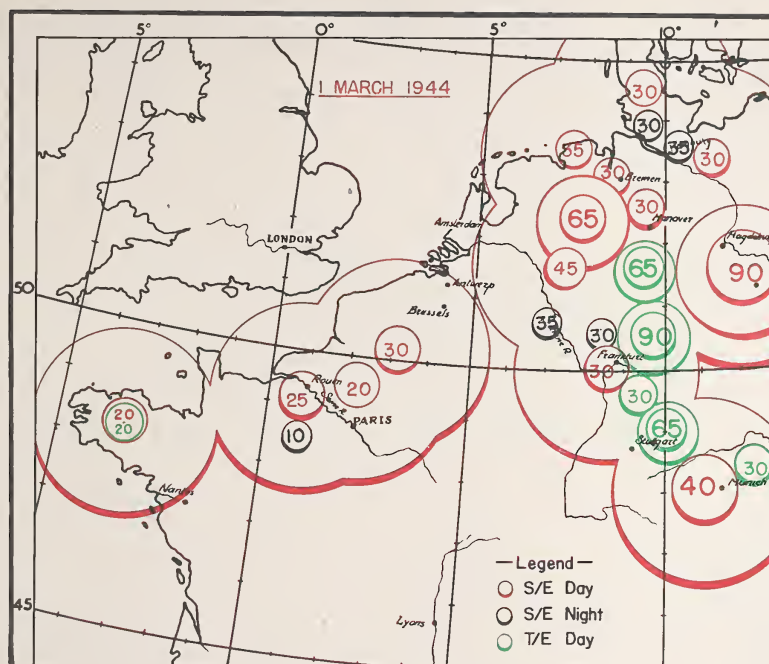


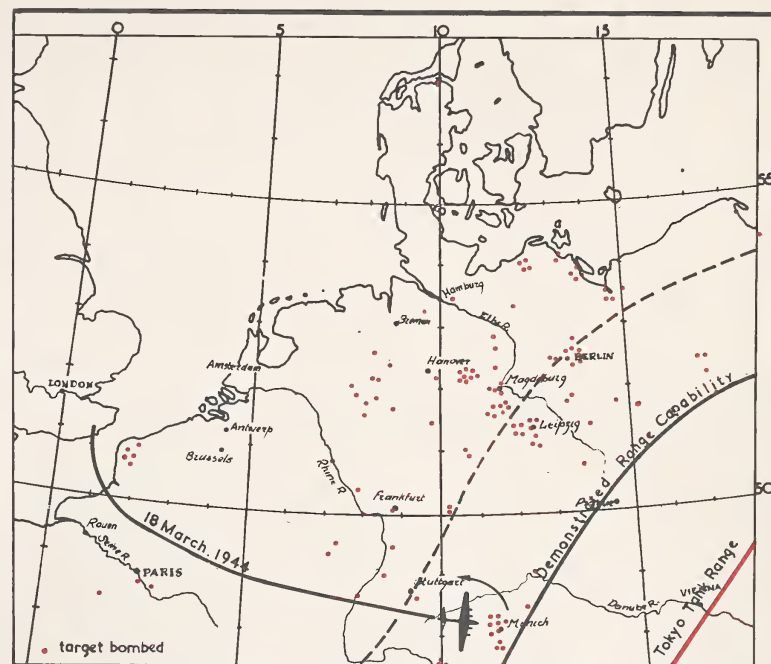
Chart A. Enemy Day-Fighter Disposition 1 March 1944

Beginning the Fourth Phase of the Air War

The German High Command now withdrew the bulk of its fighter defenses to become a potential barrier in front of the great industrial districts in Germany. A modest number of fighters remained in the more probable invasion areas: Brest, Brittany, Normandy, and the Pas de Calais. The rest, comprising single-engine day and night fighters, and the twin-engine rocket-firing day fighters, were placed in a defensive belt from Denmark, behind the Rhine down to Munich.

Secondary defenses were placed around Hanover and Brunswick, and a third defense belt even was established near Berlin.

Such a disposition provided the enemy with a force capable of large-scale concentration at virtually all of his major target areas. It was the fore-runner of massive concentrations.



FOURTH PHASE

20 Feb. 1944 20 June 1944

Chart B. Fourth Phase

With the great attack on the enemy aircraft industry of 20 February 1944, Eighth Air Force bomber-fighter teams indicated to the enemy that the force now was capable of an increased depth of penetration. On 18 March 1944, the extent of that penetration was demonstrated by an attack on Munich. Now bombers could be escorted to the bulk of Germany's vital target areas.

Our main target areas had become (1) Central Germany, from Hanover to Berlin and South to Leipzig; (2) the Baltic coast of Germany from Stettin Westward; (3) the Hamm-Munster area North of the Ruhr; (4) the Munich area; and (5) the V-bomb sites in the Pas de Calais.

This phase of the air war saw a change in Eighth Air Force tactics, from evasion to provocation intended to force the enemy air force to fight to a finish. The enemy long had refused to fight Allied fighters, but he now was forced to attempt interception of bombers even if it involved combats with the Eighth Air Force's fighter escort.

7. STRATEGIC OPERATIONS-PHASE 4. 20 FEBRUARY 1944 THROUGH 20 JUNE 1944

heavy bombing attacks. Only 32 percent were disposed on the Eastern and Mediterranean Fronts and in Scandinavia.

But further trouble was in store for him. With the invasion of Normandy he was forced to neglect for the moment his desperate defense of German industry in order to attempt to thwart the Allied landing.

So the end of this phase in the air war found most of the German Air Force of the west, disposed in the general vicinity of Normandy beachhead.

But a secondary defense was left to intercept deep bombing attacks. Single-engine night fighters used more and more in the daytime, eventually became a straight day-fighting force, and with remnants of the enemy's twin-engine day fighters, constituted most of this deep defense.

Enemy Tactics: Enemy reaction took the form of increasingly large concentrations of enemy fighters. These assembled in formations to attack heavy bomber task forces only after they had penetrated well into enemy territory. The enemy now attempted to make massive attacks with single engine fighters. In such attacks

succeeding waves of fighters flying line-abreast were exceedingly lethal to any bomber unit which had become too widely separated from its fighter escort.

The enemy was still very aggressive. He attempted to assemble all aircraft possible to make interception, bringing fighters from distances as great as 300 miles to reinforce the area under attack. But by now he had found that twin engine fighters could not live in the same sky with long range Mustangs and Lightnings.

Two new tactical developments of the enemy are of interest.

He made increasing use of scouting or "shadow" aircraft to give his controllers information about weather and the disposition of our bomber and fighter forces. He also made use of "fugitive sorties". Pilots of his twin-engine aircraft no longer wished to stay, even on the ground, in the area over which the Eighth flew. The result was that in the area which the enemy assumed an attack was coming twin-engine aircraft would make off early for points as far north as Denmark.

Offensive Fighter Missions: During the

Fourth Phase of Strategic Air Operations, the Eighth Air Force fighters demonstrated great offensive capabilities. First the fighters were permitted to "sweep the deck" on returning homeward after being relieved of escort duty. Then fighter sweeps were inaugurated to the areas where enemy fighter assemblies might be expected while the bombers were making their early penetrations.

After considerable success in these efforts fighter pilots of the Eighth became more and more offensive minded. They felt that if they were permitted to attack the enemy unhampered by the necessity of escorting bombers, dividends in crippling the enemy would result.

The pressure to carry out the bombing program within a limited period was too great to permit such experiments when weather was suitable for bombing, and at this time, virtually all weather permitted some sort of bombing attack. But eventually, the fighters had too opportunities to go on missions alone. Both days had weather conditions too poor to offer any success for a bomber attack, but just above the minimum for a fighter sweep. On 5 April 1944, weather was so bad at bases and on the Continent that the bomber force "stood down". Ten groups of fighters were assigned to straf-

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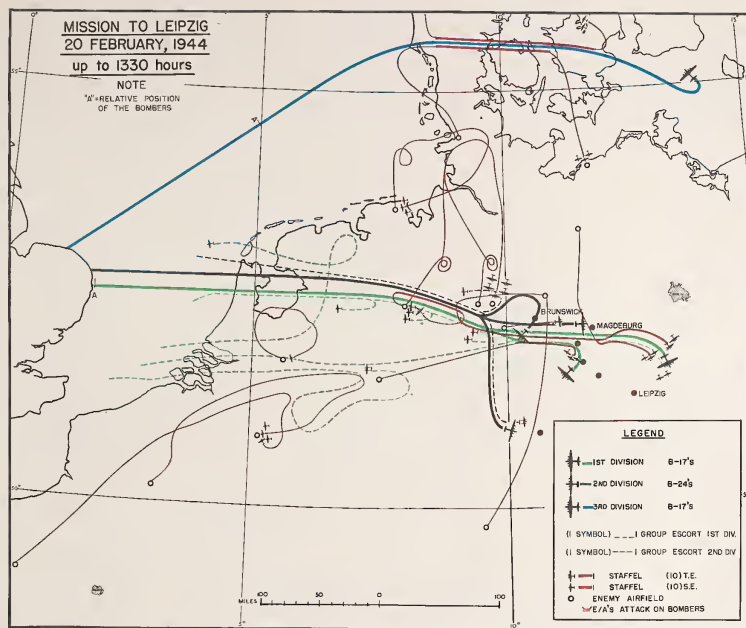


Chart A. Mission of 20 February, 1944 to Leipzig and vicinity

Penetration. The plan of operation on this day was to threaten the enemy's deep targets with a Northern bombing force, get his defenses off balance, and then thrust straight into the vital area around Leipzig, where the enemy's disposition was designed to defend with maximum power. The possibility of serious loss was great unless the enemy defenses were disrupted.

German controllers saw our first Task Force (314 B-17s) swing out over the North Sea toward Denmark. Recognizing this as a potential threat to Berlin, the enemy dispatched 50 twin-engine and 30 single-engine fighters towards the Kiel Canal. Actually its targets were in Poland.

80 minutes behind our first force, German controllers detected a second force coming straight for Holland. German observation posts soon afterwards warned that this force constituted a huge attack. Though by now the fighters sent toward Kiel had crossed the Danish border, they were recalled.

The first Task Force crossed Denmark under the attack of local defenders and flew out over the Baltic to find such bad weather that its attack was cancelled.

Our main attack, to Leipzig and vicinity was intercepted by some 60 single-engine and 30 twin-engine fighters which were engaged by our escort. One group of P-38s flying eastward to rendezvous with the bombers soundly defeated 40 or more single-engine enemy fighter reinforcements.

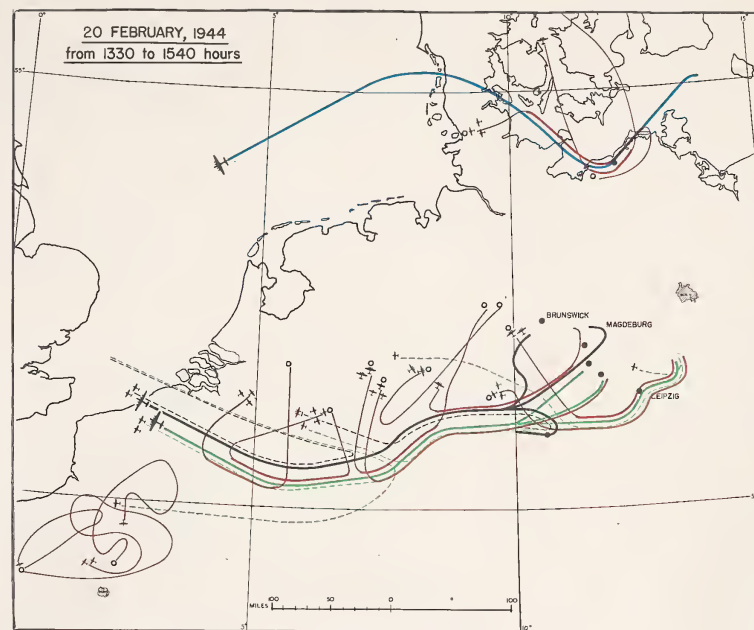


Chart B.

Withdrawal. Aircraft assembly plants at Leipzig, Brunswick, Ochersleben, Gotha, and Bernberg were bombed with good to excellent results. The Northern force, after turning back because of weather, followed the coastline with H2X equipment and bombed Rostock and Tutov through-the-overcast. Attacks were made on this force during withdrawal.

The main force, after breaking down to bomb the many targets, re-assembled to withdraw along a route south of the Ruhr. Enemy controllers had assembled a substantial force for our expected withdrawal along a reciprocal route, and about 30 single-engine fighters which had flown North and been recalled to base at Jever near the coast, were out of the fight. The 50 or more twin-engine fighters which had landed near our penetration route to refuel, now hurried southward, but were able to reach only the tail of the bomber column where Eighth Air Force fighters were ready for them. Our withdrawal continued under only small attacks.

Losses amounted to only 21 bombers out of a dispatched force of over 1,000, and 4 fighters out of more than 900 dispatched. The Eighth Air Force claimed enemy fighters destroyed, probably destroyed, and damaged to the total of 126-40-66, out of which 65-33-29 were bomber claims, and 61-7-37 were claimed by the fighters.

7. STRATEGIC OPERATIONS-PHASE 4
20 FEBRUARY 1944 THROUGH 20 JUNE 1944

ing operations at a large number of airfields over occupied territory and Germany. Weather was so bad over France, Holland, Belgium and Western Germany that groups with targets in these areas were able to do relatively little. Two P-51 groups, however, had been assigned targets deep in Germany, one in the vicinity of Berlin and the other near Munich. They found visibility such that, although few assigned targets could be found, a large number of enemy aircraft could be destroyed chiefly on the ground.

The group attacking in the Berlin area crossed 10/10ths cloud until east of Brunswick where some breaks were visible. The group dropped from 23,000 feet through the cloud when in the vicinity of Berlin and attacked five airfields through flak that ranged from moderate to intense for claims of 45 enemy aircraft destroyed, 3 probably destroyed, and 39 damaged. Only 2 aircraft were claimed in the air, the rest being attacked on the ground. Three P-51s were lost to flak and one in the

Channel the pilot of which was rescued.

The Munich attackers found similar weather conditions en route and in the target area. One assigned airfield and five airfield targets of opportunity were attacked for claims of 51-1-21, of which 8-1-2 were in air fights. Losses of the Eighth amounted to three P-51s, one to enemy aircraft, one to flak, and one to reasons unknown.

Most of the enemy aircraft destroyed were twin-engine types. The airfields attacked were only moderately defended by flak at this time and flak fire generally was of moderate intensity and fairly inaccurate.

The score for the day was 98 enemy aircraft destroyed, 4 probably destroyed, and 122 damaged, for the loss of 6 P-51s. In addition, there was a large number of miscellaneous targets attacked, such as locomotives, flak towers, gun installations, barracks, hangars, barges and enemy personnel.

On 21 May 1944, weather prevented large scale heavy bomber operations, and again the fighters were assigned a strafing mission this time against enemy transportation. Fighters from the United States Eighth and Ninth Air Forces and the Royal Air Force were assigned areas for group attack in Holland, France, Belgium and Germany. The areas assigned to the Eighth Air Force extended from the western border of Germany eastward just past Berlin, and from the North Sea and the Baltic on the North as far south as Dresden. The Eighth Air Force's areas of sweep amounted to over 60,000 square miles.

Thirteen out of the fourteen Eighth Air Force fighter groups completed their assignment in spite of very bad weather. Eighth Air Force claims are impressive. Enemy aircraft were destroyed, probably destroyed and damaged to the total of 122-0-78, of which 20-0-2 were in the air. The list of transportation and other targets destroyed and damaged follows:

(CONTINUED ON PAGE 131)

7. STRATEGIC OPERATIONS - PHASE 4.
20 FEBRUARY 1944 THROUGH 20 JUNE 1944

Rail Transportation Targets Destroyed Damaged

Locomotives	91	134
Locomotive Tender	1	-
Goods Wagons	6	7
Boxcars	3	3
Tankcars	11	-
Entire Trains	-	29 (16 on fire)
Railroad Station	-	1
Roundhouse	-	1
Switch Tower	-	1
Signal House	1	6

Other Transportation Targets

Motor Trucks	4	13
Barges	6	18
Tug	1	-
Canal Locks	-	1

Miscellaneous Targets

Small Oil Refinery	1	-
Oil Tank	-	1
Staff Car	1	-
High Tension Towers	15	2
Power Station	-	1
Radar Stations	-	2
Radar Towers	-	7
Radio Station	-	1
Radio Tower	-	1
Flak Towers & Installations	-	5

In addition, there is a long list of damaged targets, including searchlights, gun posts, ammunition depots, hangars, water towers, factories, warehouses, barracks, an ore smelter, and miscellaneous buildings.

Ninth Air Force and the Royal Air Force had additional impressive claims to those of the Eighth Air Force, enumerated above.

Besides causing a serious disruption of enemy transportation, this fighter mission must have brought the war "home" to more than half of the population of Germany.

Fighter Operations in D-Day Period: During the period of the invasion of Normandy, Eighth Air Force fighters achieved such important results that a brief description of their special employment is given below.

The success of the landings could be assured if the German forces defending the beach area could be prevented from bringing up from other areas troop reinforcements, adequate supplies, and most important, fighter aircraft. Allied tactical air forces were operating in the immediate vicinity of the ground battle. The fighter force of the Eighth received the task of extending beyond the tactical zone the area of interdiction of the German Air Force, ground reinforcements, and supplies.

There were many enemy fighters on airfields back of the ground battle area. For reasons of safety, these enemy fighters had been dispersed in woods and otherwise hidden away from the actual airfield area. In order to use these aircraft, the enemy had to bring them from dispersal. Then enough enemy fighters had to be assembled for a formation to attack the invasion beach area. One of the purposes of fighter operations of the Eighth was to prevent this assembling of enemy fighters and thus deny them any opportunity to make serious attacks.

Since Field Marshall Runstedt had been uncertain of the location of the Allied landing until the operation actually was launched, he had been forced to deploy his ground forces against potential landings all along the western coast of Europe. Other landings were still a constant threat. But as soon as he realized that the Normandy beaches represented a major invasion area, the Field Marshall began to reduce his defenses in other areas and move units toward Normandy. It was a duty of the Eighth's fighters to impede and disrupt these enemy reinforcements as early as possible.

Supply lines which the enemy had prepared to his forward units before invasion now had to be greatly expanded in order to supply a full-scale battle. Fighters of the Eighth were

ordered to impede and disrupt the enemy channels of supply, thus shortening the period of powerful defense and weakening the enemy's defensive effort against Allied ground forces.

With all these purposes in view, a plan for fighter operations was drawn up. It involved a continuous daytime sweep of an area representing a wide arc centered on Normandy and lying between the beachhead and the enemy's fighter airfields. Fighter units were to be flown in relays, each relay of sufficient size to provide an effective interdiction of the entire area of the arc.

This operation continued for many days. Eighth Air Force fighters would sweep over enemy airfields, watching for activity denoting an attempt to prepare enemy aircraft for take-off. Whenever such a take-off was attempted, it was attacked immediately with resultant destruction of some of the enemy fighters and dispersal of the rest eastward from the battle area. Many enemy fighters made "fugitive sorties" eastward in an attempt to get away, and later form up farther east to attack the battle area.

Fighter patrols of the Eighth were highly effective in disrupting enemy attempts to form up sizeable forces. No enemy fighter formations of major size penetrated the Eighth's fighter screen, which gave an immunity from enemy fighter and dive-bomber attack which was of far-reaching importance. The German ground forces were under ceaseless fighter and dive-bomber attack while Allied troops pushed their operations with the assurance that "if you see any fighter planes, they will be ours".

So many enemy troops were killed, so much motor transport destroyed, and such disruption of supply ensued that the enemy soon gave up the attempt to move any troops or supplies by daylight. With movements impeded by darkness and limited to the short period of the European summer night, the enemy defenses never built up in Normandy an adequate defensive force and local shortages in supplies soon became critical

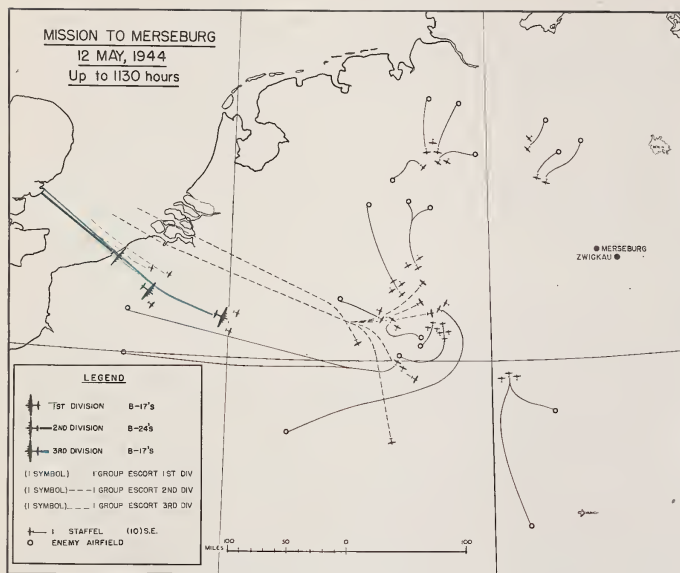


Chart A. Mission of 12 May, 1944 - Oil.

Early Penetration. Clear weather, forecast for Central Germany enabled the Eighth Air Force to initiate attacks on synthetic oil production. To double the effect of the attack, counter-air fighter sweeps were worked into the plan.

Around 700 single-engine and twin-engine enemy fighters were based within interception distance of routes toward Leipzig. It was decided that a route to Frankfurt and thence towards Leipzig would bring up the bulk of the enemy's serviceable fighters to concentrate near Frankfurt.

Our forces consisted of 15 Combat Wings (886 heavy bombers) flying as three Air Divisions, escorted by 17 Groups of fighters (5 Groups from Ninth Air Force), and supported by 4 fighter Groups on sweeps. Four Royal Air Force Mustang squadrons joined in making this the greatest number in a fighter escort force to date (total - 987 fighters).

As the bombers crossed the Belgium coast, some 350 enemy fighters were flying towards the Frankfurt area for a massive concentration. Two P-47 groups, well in advance of the bombers, made for this area. The first group, as it reached the area, split into small units and spread widely to harass the enemy's converging units. Our second fighter group remained in formation so as to be ready to make a large-scale attack on any enemy concentration reported.

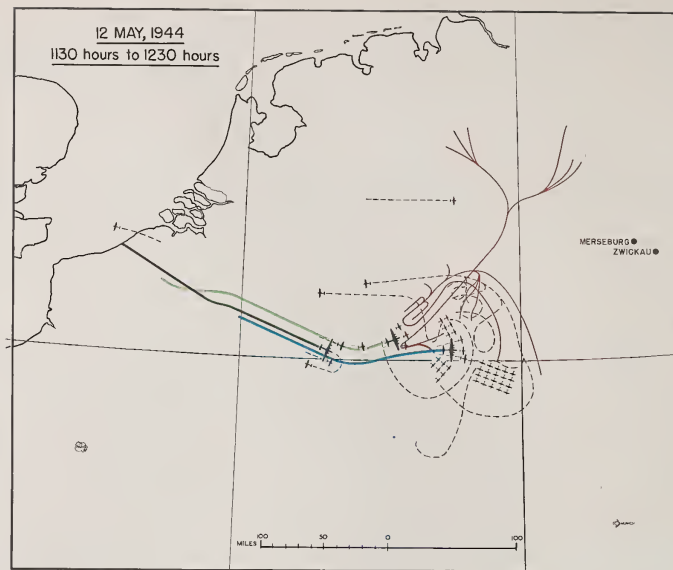


Chart B.

Continued Penetration. Our first sweeping fighter group, spread out into the so-called "Zemke Fan" formation, engaged many units of the enemy, and together with our second sweeping group, routed 175 of the enemy fighters. The whole process of the enemy's assembly was delayed and about 75 enemy fighters were effectively removed from further battle.

The 3rd Air Division, in the lead, crossed the Rhine under escort by only one fighter group, the other group assigned having rendezvoused with other bombers. At this point, 130 single-engine enemy fighters attacked, overwhelming our escort and scoring heavily against the bombers. A second escort group arrived and joined the fight, but it was not until a third fighter group joined in that equilibrium was established, and the pressure was taken off the bombers.

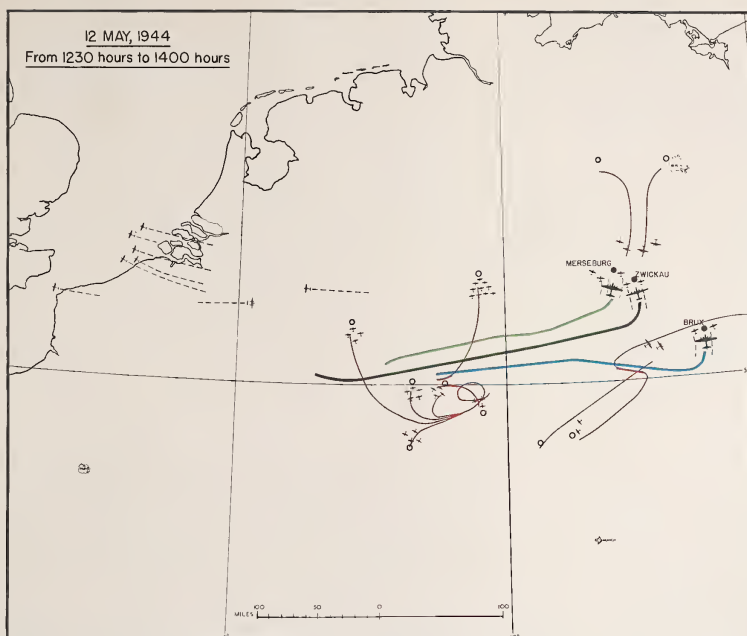


Chart C.

Final Penetration. Meanwhile, remnants of the earlier enemy assembly re-united and struck the injured 3rd Air Division another blow. Before this fight was ended, the 3rd Air Division had lost a total of 30 bombers.

Shortly afterward a further attack on the 3rd Division was attempted by about 30 single-engine fighters. But the escort was able to handle the situation without further loss. These bombers then proceeded to bomb the great synthetic oil works at Brux and the large aircraft repair depot at Zwickau with good results despite the severity of enemy interception en route.

The 1st and 2nd Air Divisions had swept past Frankfurt toward the targets unopposed. The 1st bombed the huge Leuna synthetic oil plant at Merseburg with excellent results, and the Lutzkendorf oil plant with fair results.

The 2nd Air Division bombed synthetic oil plants at Bohlen and Zeitz, both with excellent results.

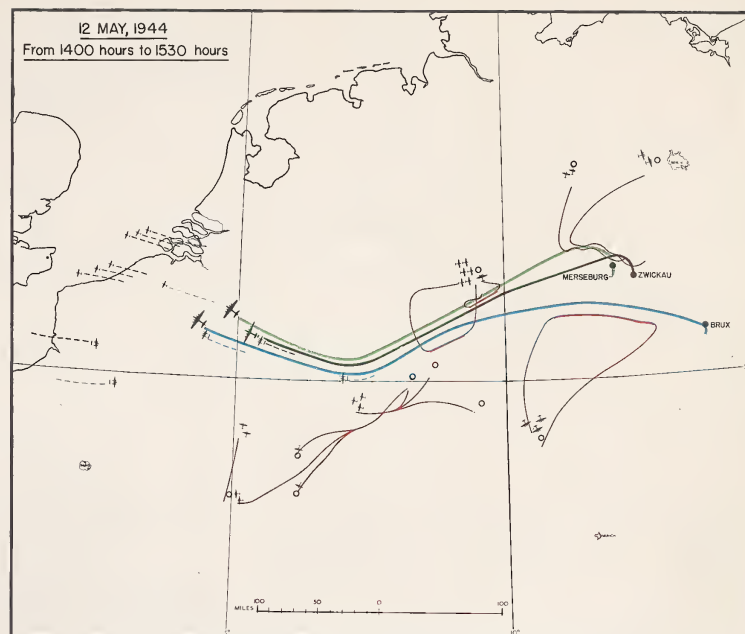


Chart D.

Withdrawal. Shortly after our bombing some 40 enemy single-engine fighters attempted interception of the 1st and 2nd Divisions but were well engaged by our escort.

30 twin-engine fighters intercepted the 3rd Division's withdrawal shortly after the target area was passed when the escort left because fuel was becoming low. The Brux raiders were now 30 minutes late.

The enemy's final interception took place near Frankfurt on the 3rd Division. Here some 100 single-engine and 10 twin-engine enemy interceptors, on second sortie, found themselves fully occupied by the relief escort which were now accompanying the 3rd Division.

Further withdrawal was uneventful.

The net result of the day was a great air victory for the Eighth Air Force plus destructive bombing of vital enemy oil production. All targets were well blanketed with high explosive and incendiary bombs.

Losses of the Eighth Air Force were 46 bombers, 41 from the 3rd Division. 10 fighters were lost. Bombers claimed 115-37-43 enemy fighters and fighters claimed 61-1-13 for a total of 181-38-56.

8. STRATEGIC OPERATIONS—PHASE 5.
21 JUNE 1944 THROUGH 8 MAY 1945

The new phase in demonstrated range capabilities began on 21 June 1944. Task Forces of the Eighth Air Force split up to attack many targets in a wide area chiefly in the vicinity of Leipzig-Dresden. One force of B-17s with Mustang escort, "hidden" by its route in relation to the other forces, bombed the synthetic oil plant at Ruhland, north of Dresden. Then, completely unnoticed by the enemy fighters heavily engaged elsewhere, the Ruhland force continued eastward to land at Poltava in Russia.

This force demonstrated clearly to the enemy that, thereafter, there was no spot in "Fortress Europe" safe from bombing. No longer

was there any belt of safety to which the enemy could remove his battered industries, military headquarters, or government offices.

Bombers of the Eighth Air Force still were flying, the 36 aircraft Group (see pages 25, 26 and 27). The bomber column, ideally, was composed of combat wings, 12 miles in trail. Each wing leader was followed at 4 mile intervals by his wing Groups, stepped off just to the side (to avoid prop-wash) on opposite sides of the line of flight.

Eighth Air Force fighters now were ranging ever wider to force the enemy into combat and

to "chase him to earth". Just prior to D-Day a Micro Early Warning Station started operating which gave "radar eyes" to our fighter controllers and pilots. In November 1944, this station moved to Luxembourg, thereby advancing its 200 mile range deeper into enemy territory.

Fighter sweeps ranged over huge areas of Germany while escort fighters guarded the bomber routes. Flying widely dispersed, they were hard to detect though they could see enemy concentrations, and a few Mustangs or Thunderbolts would "jump" a much larger enemy aggregation and effectively disrupt its assembly.

(CONTINUED ON PAGE 137)

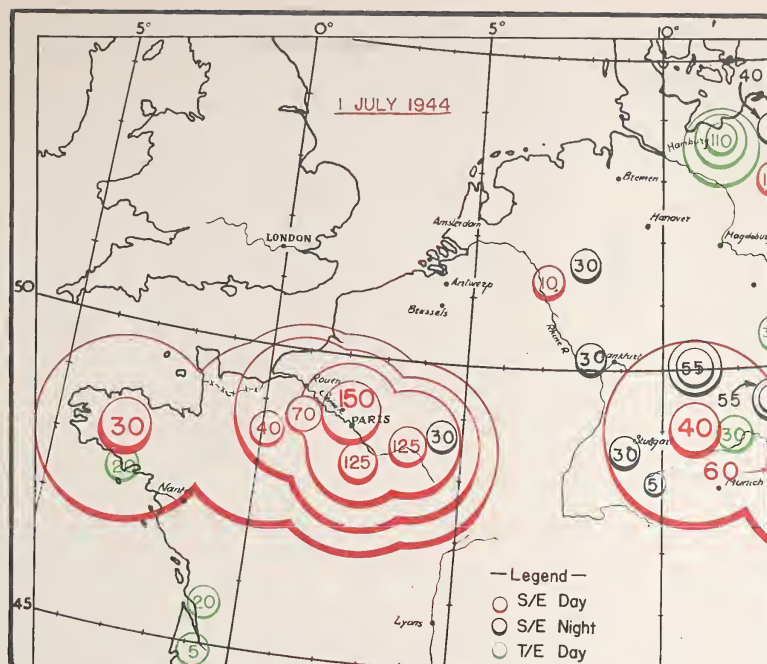


Chart A. Enemy Fighter Disposition 1 July, 1944

Beginning the Fifth Phase of the Air War

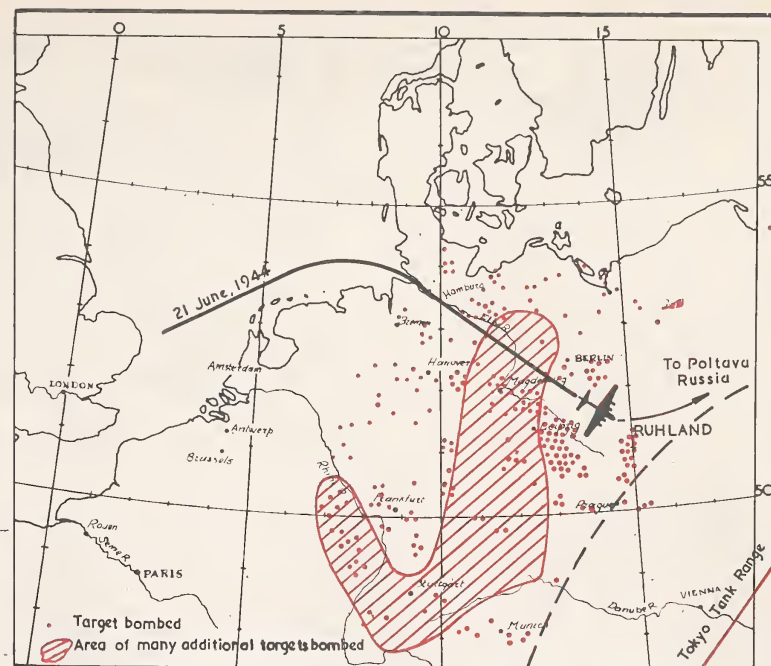
With the invasion of Normandy, the German Air Force was forced to take on an additional defensive role, despite the fact that it had shown itself incapable of defending German industry against daylight bombing attacks of the Eighth Air Force.

By three weeks after invasion, enemy fighter defenses had been split between (1) defense of the ground battle zone, and (2) defense against our deep bombing attacks. Since twin-engine German day fighters were no match for Thunderbolts, Mustangs and Lightnings, they were withdrawn toward central Germany to keep them out of the area of our greatest fighter activity. It probably was hoped that they could be used to attack unescorted bomber formations deep in Germany.

The single-engine night fighters also were disposed back of the Rhine. This force rapidly was losing any function as a night fighting force and was soon to be classed with the rest of the day fighters.

In the following month, the German Air Force High Command vacillated. If fighters were withdrawn from the Western ground battle, German ground forces would be immobilized by air attacks. Without the entire strength of the Luftwaffe to intercept bombers, there was little hope of preventing destruction of German industry. As the Russian Army later swept forward, Germany was faced with a need for air strength on the Eastern Front.

Unable to provide for all these vital needs, the High Command re-disposed the fighter force, first one way and then another, vitiating much of its defensive power.



FIFTH PHASE - 21 June, 1944 - 8 May, 1945

Chart B. Fifth Phase.

On the 21st of June, 1944, during a large scale attack on enemy synthetic oil plants near Leipzig and Dresden, one bomber force with Mustang escort bombed the oil plant at Ruhland and proceeded eastward to Russian bases near Poltava without enemy interception. This shuttle raid demonstrated to the German High Command that there was no part of the home country safe from bombing attacks. The Eighth Air Force's capabilities of penetration exceeded any requirement which the war in the West might pose.

All German territory now received our attention. But there were certain areas of concentrated attack. Leipzig, Magdeburg and Dresden areas, in that order, received tremendous tonnages of bombs. Berlin, Hanover and Brunswick areas followed in importance.

Our forces were capable of attacking more and more targets per mission as enemy defensive capabilities dwindled. Repeated attacks across great areas of Germany took in multitudes of small scale targets. Attacks on transportation, carried out both for the purpose of disrupting German economy, and for cutting of supply lines to the armed forces, were too numerous to indicate on a map.

A great air force which had gained domination of the air, now came into its full offensive capabilities.

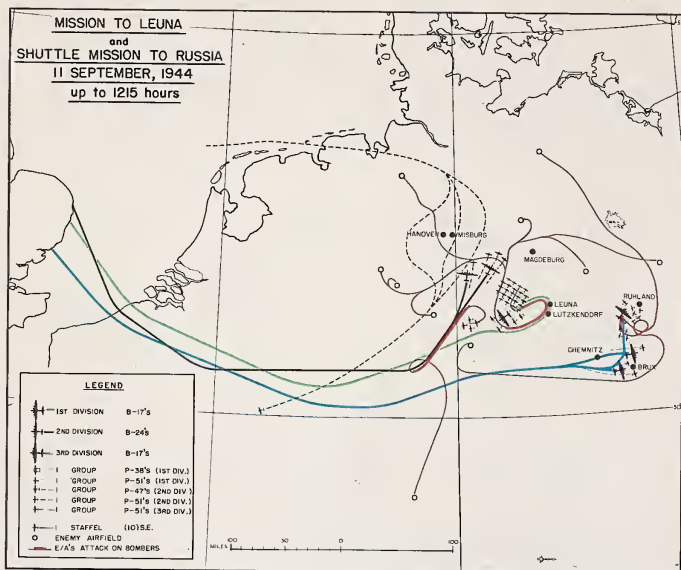


Chart A. Mission of 11 September, 1944 - to Leuna

Penetration. The weather forecast for the day of this mission was "excellent visibility everywhere on the Continent of Europe" but early fog at bases.

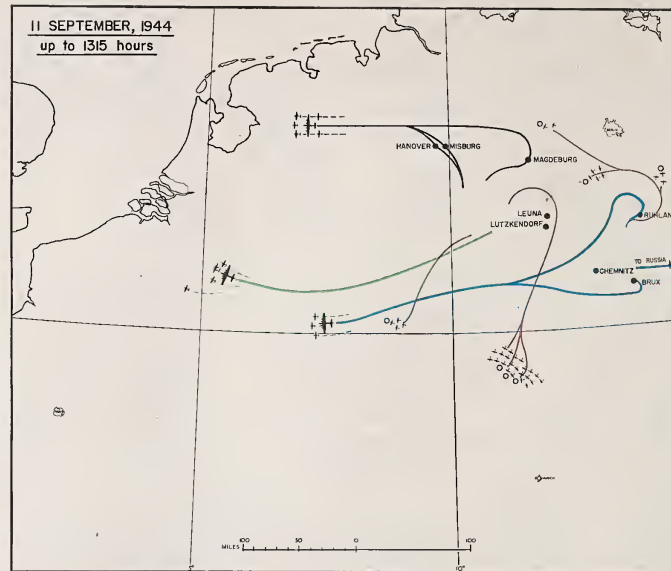
1,120 heavy bombers and 715 fighters of the Eighth Air Force were dispatched against oil targets in Germany and many other targets including a military vehicle factory, aero engine works, tire plants, and an ordnance plant.

The bombers flew in three divisions, the First and Third Air Divisions preceding the Second and flying to the Leipzig and Dresden areas deep in Germany, where many targets were bombed. One force from the Third Division bombed the Chemnitz military vehicles plant and proceeded, with Mustang escort, on to Russian bases.

The enemy put up about 380 fighters out of a serviceable strength of perhaps 455 which were within interception range of the routes.

By the time our first bombers reached the Frankfurt area, the Magdeburg enemy assembly numbered about 170 fighters. Another 110 had been prevented from joining this assembly by an Eighth Air Force fighter sweep through the Hanover area. The assembly eventually built up to about 220 fighters which attempted interception of the First Air Division bombing the Leuna Oil Plant at Merseburg. Only 20 enemy fighters got through to the bombers for a short attack. A large number of enemy fighters was shot down in this engagement by the escort with this force.

The second enemy concentration near Dresden numbering about 100 engaged the lead formation of the Third Air Division which at the time



had only one squadron of escort fighters. These enemy fighters were highly skilled. They attacked in a new formation which later became known as the "Company Front". Waves of fighters in line abreast bored down on the bombers, swamping the defensive fire. In a brief attack of this nature, 11 bombers were destroyed.

The Second Air Division had received an "inside" protective route to bomb several targets in the Magdeburg and Hanover areas. 40 enemy single-engine night fighters, which had taken off too late to join the major assemblies, found one force of Second Division B-24 out of escort as they were attempting to make up time by cutting across a dog-leg in the course. This attack, lasting perhaps 20 minutes, was made by enemy pilots unskilled in bomber attack, and only 4 bombers were lost.

Chart B

Withdrawal. Bombing generally was good at most of the large number of targets.

After bombing, withdrawal was uneventful for all forces. The enemy had committed his entire available force before the targets were reached. With 181 enemy fighters destroyed, 26 probably destroyed and 75 damaged, (according to Eighth Air Force claims) the Luftwaffe was in no condition for second sortie.

Bombers claimed 19-19-9 enemy for a loss of 40 bombers, 18 lost to enemy fighters, 13 to flak and 9 to unknown causes.

Our fighters claimed 162-7-66 enemy aircraft for a loss of 25, 6 to enemy fighters, 2 to flak, and 17 to unknown causes.

8. STRATEGIC OPERATIONS - PHASE 5.
21 JUNE 1944 THROUGH 8 MAY 1945

The area of bombing now was all of industrial Germany and the military supply lines to the west. Bomber routes varied more than at any time previously. Two-thirds of the routes left the enemy in doubt as to which of several targets were to be attacked. Considerable use was made of "hidden forces" which allowed relatively small units to turn off to attack isolated targets, or in some cases innumerable small targets, without fear of heavy loss from enemy fighters.

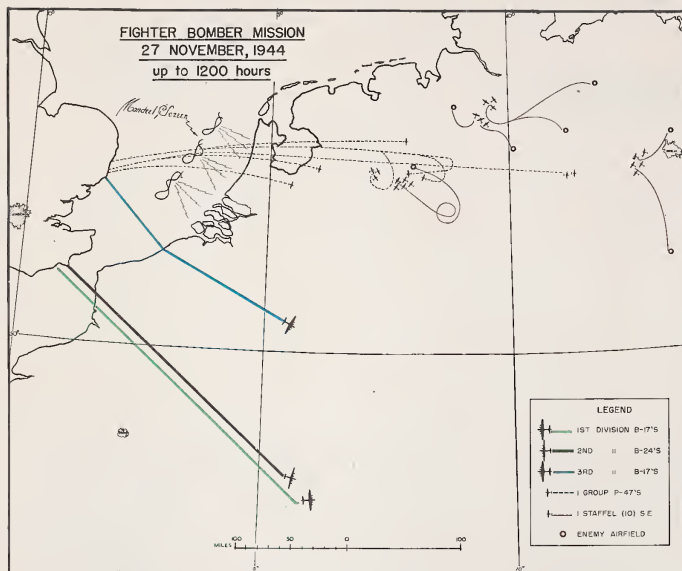
A new type of fixing attack came into frequent use. A bomber column could fly deep into enemy territory aiming directly for an

objective vital to the enemy. With a concentration of enemy fighters piling up in defense of the sensitive target the one bomber force, heavily escorted, would attack this target and engage the enemy while the rest of the bomber column turned and bombed a multitude of targets to the rear along the route. Unhampered by enemy fighter attack, these formations were able to focus all attention on accurate bombing of the target.

Enemy Reaction: With his fighter force split between defense of strategic targets and army cooperation, the enemy truly was in difficulties. He knew that further loss of oil from

bomb damage meant a quick end of the war. But his attempts at defense against our bombing attacks cost him aircraft and pilots which offset by far any results he attained. At the same time, the German ground army was demanding far more air support than the Luftwaffe could offer, and German army cooperation aircraft were already taking a terrible mauling from the Allied tactical air forces. And the Russian forces to the east had to be stopped.

Rockets and Jets: During this phase German rocket and jet-propelled aircraft made their appearance. For a detailed discussion of the aircraft see Section 3 of this chapter.

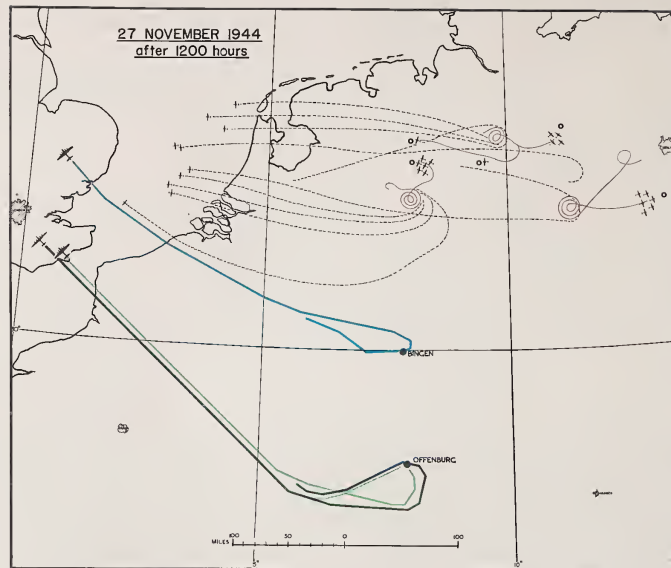


Up to 1200 hours. This mission was unique. It represented the only instance in the war that the Eighth Air Force bombers received a subordinate role, and fighters played the major part.

The Eighth's bombers, equipped with devices to jam enemy interception of our V.H.F. radio messages, were sent out early over the North Sea. Two Air Divisions of bombers with light escort flew well south over Allied Occupied territory to bomb the marshalling yard at Offenburg and another Air Division bombed the marshalling yard at Bingen, further North on the Rhine. The enemy warning system failed to pick up the southern bomber formation and "saw" the Bingen raiders only dimly. Hence, when the enemy realized that large forces of aircraft were headed over the North Sea toward the Zuider Zee, he concluded that they must be the two unseen bomber divisions.

The fact was that ten groups of our fighters were crossing the North Sea in a long column similar to a bomber formation, screened from radio interception by our countermeasures. 8-10/10 clouds over the North Sea, and broken cloud with heavy contrails inland aided in the deception.

Some 250 single-engine enemy fighters from bases between Achmer and Kassel, assembled in the Munster-Paderborn area and were then directed northwest to make interception of the supposed bombers. Three of the Eighth Air Force fighter groups were put on interception courses by Microwave Early Warning controllers, with two other groups joining in later.



After 1200 hours. A combat between some 500 fighters, enemy and friendly, ensued.

Meanwhile, 250 more enemy fighters were assembling North of Hanover. Microwave Early Warning controllers directed three other fighter groups to make interception, with the result that another large-scale fighter battle ensued.

A third enemy assembly of about 100 enemy fighters took place. These were beyond Microwave Early Warning range and their exact locality is unknown but probably was the vicinity of Brandenburg.

One group of Eighth Air Force fighter-bombers carrying a 250 pound G.P. bomb piece, successfully attacked a marshalling yard, a railroad station and an airfield near Lechfield deep in Germany and returned without incident.

Our bomber formations, with their escort, saw no enemy fighters, either before or after bombing Bingen and Offenburg through-the-overcast.

Our fighters claimed 102-4-11 enemy aircraft destroyed, probably destroyed and damaged for the loss of 11, mostly to causes unknown. Fighters also claimed 49 locomotives destroyed, 22 damaged; 14 freight cars destroyed, 106 damaged; and oil cars, coaches, barges, sheds, etc. too numerous to list.

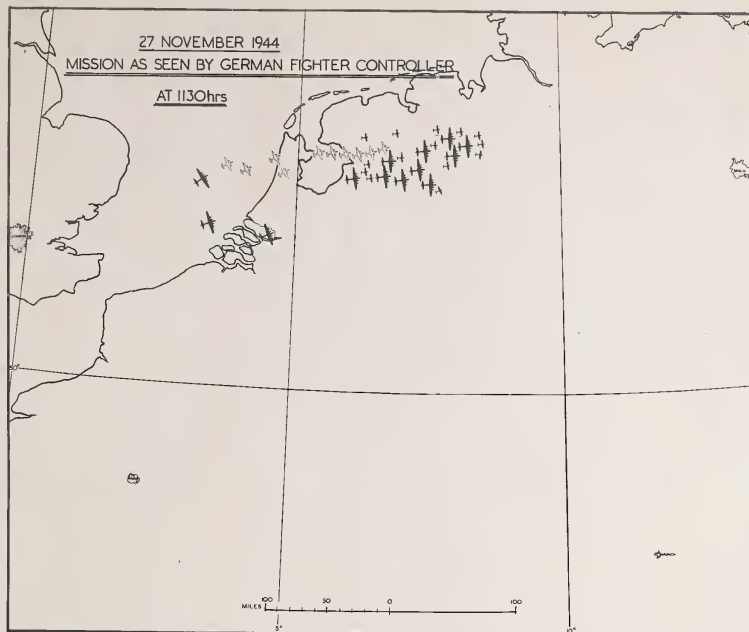


Chart C. Mission of 27 November, 1944
As "Seen" by German Fighter Controllers

1130 hours. The above maps show the plots made by enemy fighter controllers of what they believed was taking place.

At 1130 hours, the enemy was reporting a great bomber force under heavy fighter escort approaching the Weser River and extending far back over the North Sea. Specific "plots" were made where a B-17 or a fighter aircraft is shown in black. Aircraft reported as "unidentified" are shown by outlined aircraft.

The enemy, deprived of radio interception of our messages, was thoroughly confused as to the facts. Once his controllers had concluded that this great force was made up of bombers and escort, nothing seems to have shaken this belief. It is probable that conditions of cloud and contrails further deceived them.

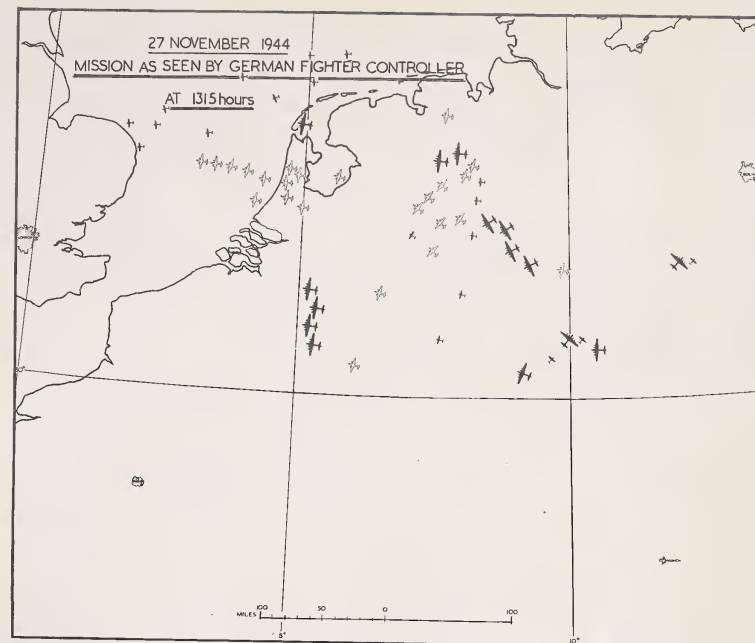


Chart D.

1315 hours. By this hour, Eighth Air Force fighters actually were crossing the Dutch coast and the perplexed enemy was plotting a wild maze of aircraft routes over much of his territory.

He indicated one force of bombers with escort fighters to be heading from the vicinity of Leipzig toward Berlin. Near Frankfurt, bombers and fighters were plotted as heading both eastward and westward. A concentration of bombers was shown flying southwestward along the east side of the Ruhr. Unidentified aircraft heading toward the west spread from the Ruhr to Heligoland Bight.

Enemy plots showed our bombers crossing westward over France when actually they had been in that area considerably earlier.

This mission, though admittedly taking place under unusual conditions, indicates the possibilities of deception opened up by a control system based on radar "watching" and radio message interception.

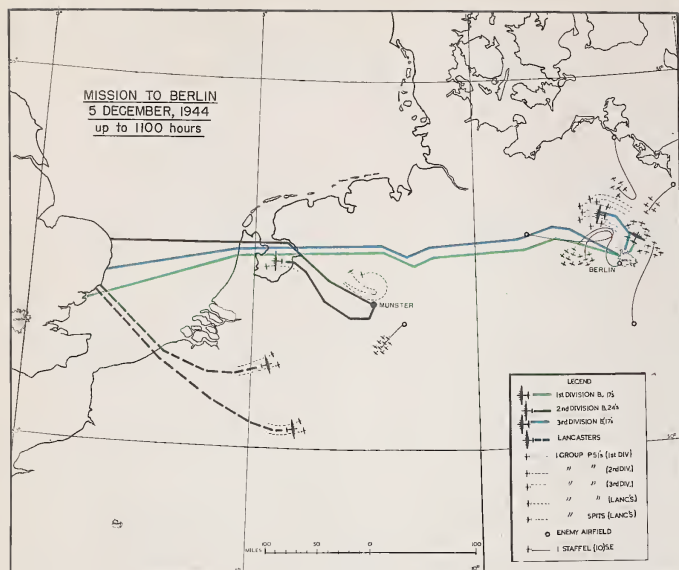


Chart A. Mission of 5 December, 1944 - Berlin

Penetration. This mission is notable first because of the proportion of fighter escort force to bombers (859 fighters dispatched with only 568 bombers); and, second, because of the complete inability of a large force of enemy fighters to penetrate the escort sufficiently to press home an attack on the bombers.

Twelve Combat Wings of bombers escorted by 12 Groups of P-51s, flew directly toward Berlin which as capital of the Reich was a sensitive spot for the enemy. Some fighters were specifically assigned to escort duty while others were free to join combat with the enemy and pursue him anywhere.

Four Combat Wings of B-24s followed the earlier bombers, turning off at Zwolle with three groups of escort fighters to bomb Munster. This light escort was permissible because of a screened route and shallow penetration.

A "mandrel" screen was flown over the North Sea in an attempt to deny the enemy access to our V.H.F. radio conversations.

About 310 single-engine enemy fighters began to assemble near Berlin. Possibly the radio countermeasures acted to disrupt their timing. At any rate, they were not fully assembled when the Eighth Air Force began bombing Berlin.

Approximately 200 single-engine enemy fighters assigned to ground attack near the ground battle area, arose to attack Royal Air Force bomber forces heading for Hamm and the Schwammenauel Dam on the Roer River, although they left our B-24s free to bomb Munster.

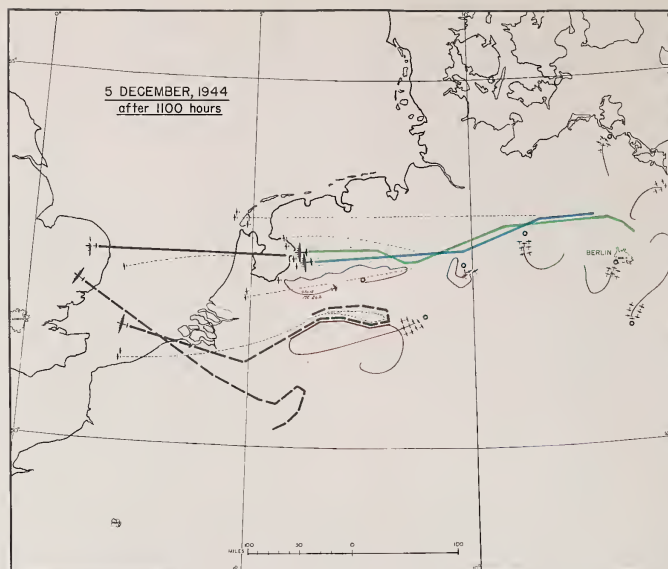


Chart B.

Withdrawal. After Berlin had been bombed, some 130 enemy fighters attempted interception but were routed by our escort without a shot being fired at the bombers. Units numbering 35 to 60 continued to attempt attacks on the bombers. But our escort had the situation so well in hand that 88 enemy fighters were destroyed in this area, one was claimed by the bombers.

Royal Air Force Lancasters with Spitfire escort were due to bomb the Hamm marshalling yards and the dam on the Roer River, as our bombers neared the same longitude on withdrawal. Of the tactical enemy fighters which rose in this area, some 75 made attempts at interception. However, Royal Air Force escort fighters engaged at least 50 of the enemy so that the attacks on the bombers were few.

About 12 Me-262s working in pairs, made an appearance in the area of Dummer Lake. Mustang escort prevented attacks on the Fortresses.

Eighth Air Force fighters claimed 90-7-24 enemy aircraft destroyed, probably destroyed and damaged. The bombers made no claims.

12 bombers were lost, none to enemy fighters, 8 to flak, and 4 to unknown causes. 18 fighters were lost, only 4 of which were to enemy fighters.

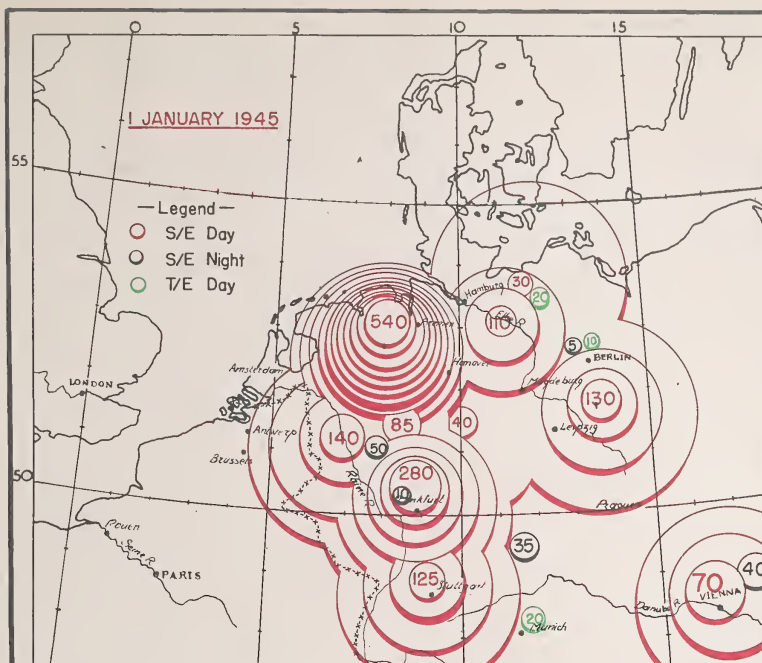


Chart A. Enemy Fighter Disposition

1 January, 1945

With the ground battle lines now at the Rhine, enemy fighters were concentrated in Germany. The number of aircraft had increased considerably, but the quality of pilots had deteriorated.

The above disposition represents the enemy's attempt to solve his dilemma. The entire strength of the German Air Force was insufficient either for ground battle cooperation or defense against heavy bomber operations. Hence, much of enemy fighter strength was disposed where it might be used for both purposes. A purely strategic defensive disposition was still maintained around Berlin.

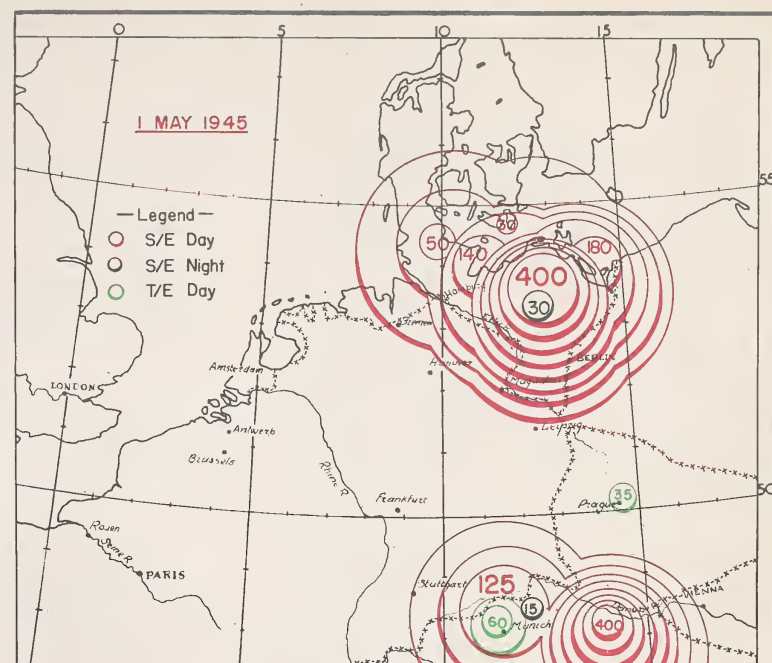


Chart B. Enemy Fighter Disposition, 1 May, 1945

Just Before the End of the War.

Just before the final collapse of German armed resistance, the Allied armies and the Red army had joined up, cutting Germany in two. The Luftwaffe was thus split into a Northern and a Southern disposition.

Numbers of aircraft still were large. But combat effectiveness of the force was gone.

9. TACTICAL EMPLOYMENT

Summary of the Invasion: On 6 June 1944, Allied airborne and seaborne forces landed on the coast of France to launch a full-scale assault upon "Fortress Europe" from the west. The initial landings, preceded by powerful air and naval bombardment, took place along a wide front between Cherbourg and Le Havre.

More than 4,000 ships with several thousand smaller craft made the rough crossing to a landing just after daybreak. There was a full moon but the weather was poor after having already caused a 3 day postponement. Naval bombardment covered the landings, and mine-sweepers helped in clearing the Channel. An unprecedented fighter concentration guarded the invasion assembly and intercepted or chased away the few German aircraft which appeared.

Months of air bombardment had weakened the foe. In early spring battles the Eighth Air Force, with the help of the Royal Air Force, had rendered the Luftwaffe ineffective. The bombing of the French railway system, and precision attacks upon the Seine and Loire bridges, seriously hindered mobility of the Wehrmacht. Beginning on "D" minus 30 the Eighth Air Force and Royal Air Force attacked coastal batteries, headquarters, radar and radio installations, crippling defenses and disrupting communications. Field Marshal Rundstedt had the difficult task of disposing his forces so as to anticipate the main thrust of the Allied invasion. These air attacks were sufficiently widespread to make him uncertain to the last concerning where it would come. Meanwhile, low-flying fighters and medium bombers concentrated on road and rail targets, and subjected enemy movements in Northern France during the entire thirty days before D-Day to harassing attacks.

Because of this preparation by air and sea power, the invasion went according to plan. By the morning of the 7th, several beachheads had been consolidated, and advances up to 10 miles inland had been made in some areas. Mr. Churchill told the House of Commons that General Eisenhower had achieved "tactical surprise".

Initially the Germans were slow to react. Still dazed by dawn attacks of the Eighth Air Force, enemy coastal defense units failed to prevent a link-up between detachments of Allied paratroops holding bridges across the Orne River Canal, and Allied troops moving inland from the coast. As a result Bayeux was

captured, cutting the main highway and railroad from Paris. Fighting also was taking place in the streets of Caen, 15 miles to the southeast.

Troops landing further west took the coastal towns to the northwest of Bayeux and advanced inland to join with airborne units. Still others came ashore in the southeastern crook of the Cherbourg Peninsula then pushed west and northwest to link up with paratroopers further inland.

Against these forces Rundstedt committed 22 divisions. He disposed four Panzer divisions to defend the Caen area alone, confirming the importance which the Allies placed on this communication hub. SHAEF reported the total strength of the German army in France to be 60 divisions, some of uncertain quality.

On June 11th, after five days of bitter fighting and continued reinforcement, Field Marshall (then General) Montgomery said: "The beaches are now behind us".

Immediately after D-Day the role of air-power was two-fold: (1) to isolate and neutralize the battle zone (2) to destroy transportation and communication within its confines. While heavy bombers attacked rail junctions feeding the battle area, and post-holed airfields in the vicinity, fighter-bombers stalked enemy motor transport, tanks, and troop concentrations. Systematically, Allied air-power paralyzed the four principal lateral railroads in the Brittany-Paris arc, thereby placing a heavy strain on motor transport. The enemy found it unsafe to move except by night.

In the face of this incessant bombardment enemy air reaction was sporadic and ineffective.

During the period June 6 to 10, Allied Air Forces flew 32,500 sorties and dropped at least 27,000 tons of bombs. In spite of this record effort, Allied losses were extremely light.

By the evening of the 13th, Allied troops had expanded their beachheads as far inland as 20 miles at the point of deepest penetration and were fighting along an 80-mile front extending in a long curve from Montebourg on the Cherbourg Peninsula to Escoville about 5 miles east of Caen.

At this point General Eisenhower summed up the situation for his troops with the following words:

"Although the landing operation was attended by hazards and difficulties greater than have ever before faced an invading army, the first great obstacle has been surmounted".

Preparation for the Invasion: To prepare for ground invasion, the Eighth Air Force, along with all the other Air Forces, was committed to a broad program to insure the success of the beachhead. The part which the Eighth Air Force was to play can be seen from the following list of assignments: first, to continue the attack on the Luftwaffe through bombing enemy airframe and engine factories, assembly plants, accessory plants, and aircraft on the ground. Second, to bomb strategic rail centers, particularly those with servicing and repair facilities essential to the maintenance of rail communication in Northern France, the Low Countries and Western Germany. Third, to bomb the coastal defense batteries, V-weapon sites and selected naval installations. Fourth, to interdict all airfields in an arc 130 miles from Caen in Normandy.

The tempo of bombing rose. A major effort was made to utilize all possible weather in order to get maximum effect on the targets selected. The Luftwaffe, realizing that the tempo could mean only one thing - invasion - made increasing attempt to intercept. The rate of attrition of enemy fighters began to rise.

Bombing of coastal installations took place equally at various points. The arc of our bombing gave no focus to any potential location for the landings. In 15 days of tactical operation prior to D-Day, the Eighth Air Force made attacks on 52 airfields, 45 marshalling yards and 14 bridges. In addition, 6 attacks were made on coastal fortifications, 4 on gun positions and several other bombing attacks and fighter sweeps against transportation in Northwest Germany.

The attack on rail transportation was successful in disrupting seriously, the enemy's communications. Bridges were destroyed over the Seine, marshalling yards were interdicted. Also, the attack destroyed many locomotives and much rolling stock. Facilities and equipment of all kinds were smashed.

Highway transportation was seriously interrupted. Road bridges and choke points in towns were destroyed. The enemy was forced into much cross-country movement of traffic. Telephone and telegraph lines adjacent to road

(CONTINUED ON PAGE 143)

9. TACTICAL EMPLOYMENT

and railroads were seriously injured.

The Luftwaffe was forced to withdraw to airfields further and further from the coastal area. Though he could repair some airfields rapidly, the multitude of airfields now under attack, plus the injury to his force and equipment, was more than he could stand. Enemy air resistance in the forward area became smaller and smaller.

D-Day: On D-Day itself 1,350 bombers of the Eighth Air Force formed up in 225 squadrons of six aircraft each. This huge force made a pre-dawn assembly and followed the route which would give them a right-angle attack on the beach targets. This would give the H2X overcast bombing equipment a clearly defined line at the beach, minimizing risk of bombing our own troops. Over 1,000 of the bombers attacked beach installations, while small forces attacked Caen and alternative targets.

Because of overcast weather, extra safety factors had been added to prevent bombing of friendly troops. This resulted in placing the weight of our bombs 300 to 400 yards behind the beaches. The effects of shock and disruption on the enemy were tremendous. Huge clouds of smoke and dust arose, acting as a screen to the landing operations.

Enemy air reaction was negligible, the only bomber losses being to enemy ground defenses.

Three other missions were flown during the day by the Eighth Air Force. Gee-H Pathfinder aircraft lead some bombers in to attack road choke points in Caen, while our fighters swept the skies surrounding the area. Other forces were directed to transportation choke points in towns, some to the south and some to the east of the beachhead. H2X technique was used because of the overcast and the fact that the targets were beyond the range of our Gee-H stations. Though hampered by bad weather, both for assembly, route and bombing, good results were obtained.

On these latter missions no enemy aircraft appeared and even the ground fire was meager. The only aircraft lost were two bombers which collided due to bad visibility conditions.

Fighter Operations on D-Day: Fighter operations virtually were continuous throughout the day. Two-thirds of the Eighth Air Force

fighters were employed during the periods of the bombing missions and one-third during intervals between the missions. Fighter-bomber attacks were executed against 17 railroad and road bridges, 10 marshalling yards, 4 railroad junctions and a multitude of miscellaneous targets. What few enemy aircraft appeared, were promptly engaged and the skies swept clear. 28 enemy fighters were destroyed and 14 damaged to 5 Eighth Air Force fighters lost to enemy aircraft attack.

Tactical Operations after D-Day: Tactical operations in the eleven months after D-Day until the end of the war may be placed in the following categories:

- (1) cooperation with ground forces to break through the enemy lines;
- (2) Attacks to neutralize enemy strong-points;
- (3) Missions to supply forward ground elements;
- (4) Missions to neutralize the enemy counter-offensive;
- (5) Missions to cause general disruption of enemy supplies and communications.

Break-through Operations: Operations of this nature were carried out at Caen on the 18 July and the 8 August 1944; at St. Lo on the 24 and 25 July 1944; and at Eschweiler on 16 November 1944. These operations were carried out by the Eighth Air Force and various other air forces. All accomplished the objective: namely, to paralyze the enemy defense long enough for our ground forces to exploit the situation and break-through the enemy lines.

By the time the mission was run at Eschweiler in November techniques had been developed, and many security measures adopted, to eliminate hazard to Allied ground troops from our bombing. Earlier missions had been marred by small numerical losses to Allied troops. These losses, unavoidable under the circumstances, were negligible compared to the results of the bombing. The ease with which Allied ground forces were able to exploit the paralyzing effect on the enemy of Eighth Air Force bombing, reduced over-all casualties for these operations to a major degree including the small number of casualties resulting from friendly bombing fire. Had the same troops moved forward under a huge rolling barrage of artillery fire required to accomplish a similar result, the losses probably would have been far greater.

Attacks to Neutralize Enemy Strongpoints: The Third Army's victorious sweep across France halted temporarily at the fortifications near Metz. Further advance was imperative. A direct assault on the Metz fortifications would have resulted in too great losses, and General Patton requested the cooperation of the Eighth Air Force.

The routes along which the Third Army wished to proceed eastward were under the short-range fire of the Metz forts. A temporary silencing of these forts was required. The Eighth Air Force agreed to bomb targets around Metz and Thionville to accomplish this purpose.

Bad weather persisted during the limited period allowed for this mission. Again overcast bombing techniques were employed. Though the bombing caused the enemy small loss of life, the desired result was accomplished. The shock of mass bombing, and the confusion which arose amid smoke and dust, permitted the Third Army to continue its advance.

Missions to Supply Forward Ground Elements: The Eighth Air Force was called upon to deliver supplies at various periods under many conditions. Perhaps the most spectacular deliveries were those to Allied airborne troops near Arnhem; the supply dropping to the French Maquis; and to the Poles in Warsaw; and the delivery of fuel to forward tank elements after the Rhine crossing. Supply dropping became more accurate as experience was gained and better techniques were developed. In their final form, they made possible a far greater exploitation for our ranging tanks when the tanks broke through the enemy lines.

Missions to Neutralize the Enemy Counter-Offensive: Field Marshall Rundstedt's counter-offensive in the Ardennes Forest on 16 December 1944, committed two armies to the attack with wholly new tactics for the enemy. The terrain and cover permitted a type of guerrilla warfare which the enemy carried on with great skill. Though at the same time this terrain afforded some obstacles and impediments to the enemy, it gave far greater difficulty to us, because the enemy had control of the roads crossing the area.

The redeployment of Allied ground forces to stop the enemy's thrust presented a difficult problem. The nature and direction of the thrust suggested a number of possible enemy objectives. Redeployment which would secure

(CONTINUED ON PAGE 144)

9. TACTICAL EMPLOYMENT

against all, would thin out and weaken the Allied Forces.

General Eisenhower's strategy was to dry up the power of the German Army at its source, while confining its offensive within a limited area. To help carry out these tactics the Eighth Air Force was called upon to bomb marshalling yards and communication centers east of the base of the German salient, with the object of denying mobility to the enemy and at the same time cutting his supply lines.

The power of the enemy's thrust was not spent until a ten-day advance had brought him near the line of the Meuse River. He had not been permitted to swing northward to capture the Allied supply base at Liege. At the Meuse, he found the river swollen with torrential rains, and the only bridges powerfully held by our ground forces.

By now the accumulative effect of bombing had dried up his flow of supplies and replacements. By January 1, 1945 his forward elements had withdrawn as far eastward as Rochefort. The momentum of his attack was spent.

Now began the painful task of withdrawing from his salient, hampered by lack of fuel, weakened by lack of replacements, and under powerful attacks on the ground and in the air whenever weather permitted. The distance which his penetration had covered in ten days took Von Runstedt 30 days for withdrawal at the cost of serious depletion of his weapons and equipment.

German generals are practically unanimous

in their opinion that the tactical use of our air during this counter-offensive was decisive in frustrating this counter-offensive.

Missions to Cause General Disruption of Enemy Supplies and Communications: After D-Day the Eighth Air Force periodically was assigned the task of disrupting enemy rail communications. To begin with, the attack on great marshalling yards, commenced many months previously, was continued.

The most important marshalling yards were ones through which huge volumes of materials passed on the way to enemy manufacturing centers. By bombing these great marshalling yards, the flow of materials for war manufacture was disrupted, first, by the damage to the marshalling yards, second, by the destruction of locomotives, and rolling stock; third, by the dislocation of facilities necessary for railroad and good repairs; and fourth, by loss of the actual materials in transit. Such attacks resulted in slowing down Germany's entire war economy; they constituted a means for preventing the delivery of weapons to German soldiers.

Other great marshalling yards, further forward, were great reservoirs of supplies going directly into military use. Bombing missions against these marshalling yards were direct attacks on the immediate supply lines of the armed forces.

Toward the end of 1944, the large marshalling yards had been thoroughly interdicted. A new phase in transportation attack now began, against a profusion of smaller marshalling yards

serving smaller industrial communities, and acting as diversion centers for traffic which the great marshalling yards no longer could handle.

With enemy air defenses waning, task forces of the Eighth Air Force could break down into smaller units and attack a multitude of targets on any one mission. These smaller marshalling yards became the focus of this type of attack.

On 22 February, the entire Allied air force was ordered to break down into squadrons and attack a series of rail junctions, bridges and intersections extending all the way from the Swiss-German frontier to the Baltic. This attack signified that the exploitation phase in the air war had commenced. Individual squadrons bombed these targets while fighters provided a protective screen between the target areas and the areas of enemy fighter disposition.

Since these small targets were far too numerous for the enemy to defend by anti-aircraft installations, Eighth Air Force bombers were able to bomb at much lower altitudes than on previous attacks with considerably increased accuracy. This attack met with small losses and was repeated the next day.

It is too early to have a final judgment on the effect of this exploitation program. However, it is now known that air operations against transportation across the whole width of Germany, north and south, resulted in the paralysis of the enemy's industrial and economic war machine, which resulted directly in the speedy collapse of German armed resistance.

10. SUMMARY OF ACCOMPLISHMENTS OF THE EIGHTH AIR FORCE

The outstanding accomplishments of the Eighth Air Force were first, the destruction of the German Air Force as an effective military machine; second, the destruction of German oil in cooperation with the other Allied Air Forces; and third, the disruption of the German economic and industrial machine through attacks on transportation, also a cooperative undertaking.

The Defeat of the German Air Force: The defeat of the German Air Force was peculiarly an Eighth Air Force task. The Eighth Air Force was the major instrument over a period of nearly three years in fighting the German Air Force in daylight and forcing the German Air Force into a war of attrition which would consume its combat strength. The strategy of

attack was based on two conceptions. The first was that an experienced pilot was irreplaceable; that a pilot eliminated, therefore, was worth far more than a destroyed aircraft alone. Second, that time for manufacture of aircraft could not be replaced; that by disrupting the enemy's aircraft industry and by preventing the expansion of the Luftwaffe at a time when the

(CONTINUED ON PAGE 145)

IO. SUMMARY OF ACCOMPLISHMENTS OF THE EIGHTH AIR FORCE.

Allies were building up rapidly, Germany would lose ground in the race for air supremacy which the nation never could recover.

In gaining victory over the German Air Force in the air, with resulting heavy German pilot loss, the outstanding factor was the American long-range fighter. Its first appearance on the front was followed rapidly by large numbers of the aircraft. Hence, the tactical advantage gained was not lost by permitting the enemy to study this new weapon and prepare defenses before the weapon could be exploited in large numbers. The result was that the Germans never developed effective tactics to cope with long-range fighters used by the Eighth Air Force.

Before the Eighth Air Force bombing of the German aircraft industry was begun, factories for the assembly of aircraft were known to be easily replaceable. But it was realized that a delay in enemy production would be effective in giving America's huge and growing aircraft output a chance to gain overwhelming numerical superiority.

Because the enemy's aircraft assembly plants offered accessible targets and other

target systems in aircraft production were not so accessible, assembly and component plants were chosen for attack. It was realized also that the part of the target most valuable to the enemy - skilled workmen - rarely would be destroyed by bombing. However, the attack on German aircraft assembly was pressed with such vigor that plant dispersal and the construction of underground factories so inconvenienced and delayed the Germans that they were effectively out-distanced by the Allies in the race to build-up production and first line strength.

Destruction of German Oil: Attacks by the various Allied air forces reduced below the barest minimum, production oil giving mobility to the German forces in the air, on the ground and at sea. The oil offensive hinged on successful crippling of the aggregation of refineries at Ploesti. Once this had been accomplished, the drying up of the German oil supply became an attainable objective.

With the advent of long-range fighters, the Eighth Air Force gained a capability of penetrating enemy defenses sufficient to attack all synthetic oil plants and crude oil refineries in Germany. This program, once initiated, was pressed forward with all possible vigor. The results were accumulative. Resulting shortages

of aviation fuel reduced both the enemy's capacity to resist with his air force attacks on oil, and his ability to train pilot replacements.

The drying up of the oil supply at its source greatly weakened the German ground army, through loss of mobility in the armored forces themselves, through a reduction in motorized transport and supplies.

Destruction of the German Transportation System: The second objective of the Eighth Air Force was to cripple the German military, economic and industrial capacity to wage war. Cutting supply lines is a time-honored method of crippling a military machine, but a new factor in war, made possible by strategic bombing, is the crippling of supply lines to vital industries in the enemy country. The Eighth Air Force, with other air forces in the European Theater, joined in the attack on supply lines behind the German Army. This attack simultaneously disrupted the transportation system of Germany to the point where industrial production came virtually to a standstill.

The bombing of German rail transportation, motor and canal traffic systems was augmented by the attacks on oil.

II. THE AIR WAR WITH GERMANY

Judged in the Light of the Principles of War

America's use of strategic air power was based on a strategy of limited aims which were to be arrived at according to a time schedule based on the intended date of invasion.

These were attained both in effect and on time.

Absence of enemy air interference at the time of invasion, and the relative immunity of Allied troops from air attack during the rest of the war, resulted directly from the ascendancy over the German Air Force gained by the time of invasion and maintained thereafter.

How thoroughly air power crippled Germany's capacity to resist is indicated by the rapidity

of the collapse of the Wehrmacht - 11 months after the invasion. High German officers and officials confirm this.

So America's air strategy was highly successful. Because of Allied air domination, moderate sized land forces were able to carry out a difficult and hazardous crossing of an extensive water barrier and achieve a successful landing without air opposition; then invade to the heart of enemy power and thereafter rapidly force a complete military collapse. This took place with a loss of Allied lives which was most economic when considered in terms of past landing operations.

Offensive action was fundamental to the tactics employed. When an Eighth Air Force bomber-fighter team fought its way to enemy ter-

gets and back to base, it accomplished two offensive purposes. Not only had enemy targets been bombed and disrupted, but enemy fighters had been destroyed and enemy pilots killed. It was the persistent pressure of this dual air attack which achieved and thereafter maintained air supremacy. Our long-range and short-range fighters had a primary defensive assignment; to protect bombers. But the tactics used by the Eighth Air Force in carrying out its assignment took this offensive form: the best way to defend the bombers was to destroy the effectiveness of the enemy air force. A sure way to draw enemy fighters into combat was to use the bombers as bait and by attacking vital targets force the enemy to intercept. Therefore, escorted bombers provided the best way for fighters of the Eighth to go on the offensive against the German Air Force.

(CONTINUED ON PAGE 146)

II. THE AIR WAR WITH GERMANY

The primary aim of the Eighth Air Force during decisive phases of the war was to meet the enemy and destroy him. Hence, the decision of the enemy to oppose a concentration of force with mass fighter attacks suited our aim of gaining air supremacy within a limited time. Because the Eighth's purpose was to cripple the enemy's air force in being, cripple his capacity to replace aircraft and crews, deny him much of his aircraft repair facilities and, in the meantime, continue the build-up of our own forces, it was a continuing objective to induce maximum fighter opposition on every mission launched. It was believed that by forcing early maximum opposition, the cost of defeating the German Air Force would be minimized.

The Eighth Air Force was continuously available, when required in the interests of security. Two major security assignments were undertaken. The V-weapons threatened the terminal of the Allied supply lines. It was essential that full exploitation of these weapons be prevented. Earlier, the successes of German submarines against Atlantic supply lines called for the application of all available force to prevent further sinkings. These security tasks were carried out at some expense to strategical operations.

Surprise was obtained, strategically, through weapons which initially were discounted by the enemy for too long to permit him to counter successfully. The enemy apparently believed that daylight bombing could not be carried out continuously or in such a manner as to constitute a real danger to Germany's war economy. High German officials also found it inconceivable that fighters could be constructed by the Allies so as to have both long-range, and first-rate combat capability. They refused to believe this until P-51s and P-38s were escorting bombers deep into the Reich.

Tactical surprise was obtained by Eighth Air Force fighters each time the range of our P-47s was increased by larger tanks. There also, were a number of occasions when tactical surprise was obtained and exploited by our bomber force with great success. But generally, bomber missions were provocative in purpose with the destruction of enemy fighters as one of the major objectives. It was decided that if sur-

prise would cause reduction in the number of enemy fighters intercepting, then efforts to surprise the enemy should be dispensed with since they would reduce potential success.

Mobility was inherent in the Eighth Air Force. Unlike the Luftwaffe, it was not faced with the necessity of providing mobility in strategic disposition. Eighth Air Force bases remained permanent throughout the war, even when French, Belgian, and German territory was available. No useful increase in capability would have resulted from movement to more advanced bases, largely because of the logistic limitations involved.

Flexibility was present to a high degree in the operations of the Eighth Air Force fighter force. Early tactics which tied the escort to the bombers were fairly inflexible. But later tactics, which permitted part of the fighters to chase enemy fighters wherever they went, made the force increasingly flexible. Permission to "sweep the deck" after escort duty provided even further improvement.

The requirement to fly bombers in large formations denied much route flexibility to the bomber force. However, it became increasingly flexible in its ability to attack targets.

Cooperation was maintained to a high degree between the Eighth Air Force fighters and bombers. Cooperation between the Ninth and the Eighth Air Forces was good. And the Eighth Air Force cooperation with the ground forces helped to secure ground successes on numerous occasions when the Eighth Air Force was requested to provide an addition of fire power in the ground battle.

The German Air Force

The strategic use of the German Air Force in the west by 1942 had become defensive primarily. Much of this force was disposed for interception of Royal Air Force night bombers. The enemy daylight fighter force was disposed in a coastal defense zone extending from Denmark to the Bay of Biscay, and entirely defensive in purpose. Germany's bomber force was not large and lacked capability for sustained operation because bomber production was being curtailed

in favor of fighters.

Hence, the enemy's use of his air force missed the major point concerning air power: that its greatest value in war is as an offensive weapon.

The enemy had no insurmountable difficulty in concentrating his fighters against Eighth Air Force attacks during many months of the air war. As soon as our bomber force reached sufficient proportions to require mass interception, enemy controllers employed radar and radio intercepts to provide warning of impending attacks. This warning, plus the time used by the bombers in reaching enemy territory, gave the enemy adequate time to assemble defensive forces even from extended dispositions. However, later in the war, Eighth Air Force fighter sweeps often hindered or disrupted enemy assemblies.

But the Luftwaffe's tactics in applying fighter attacks against our bombers were, during most of the war, a violation of the principle of concentration. Interceptions were made when and where various enemy units could make them, without reference to other units. Later in the war after the German Air Force fighter force had lost much of its combat capability for decisive action, the enemy evolved somewhat sounder tactics. Large assemblies were carried out with the purpose of making mass attacks to swamp our defenses. He continued weak, however, in the matter of concentrating his attacks on single formations, with the object of swamping the bomber defense, depleting the limited supply of ammunition, and gaining the accumulated effect of sustained attack.

Surprise was difficult of attainment by the enemy against the Eighth's Task Forces since these were constantly disposed in a defensive attitude. The enemy had some success with numerous small-scale ruses. But he never accomplished a major success through surprise - and he missed many good opportunities.

Instead of varying his tactics radically, from time to time, the enemy tended strongly to pattern in his operations. A large-scale surprise attack on airfields in the United Kingdom, for example, might have caused difficulty and

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II. THE AIR WAR WITH GERMANY

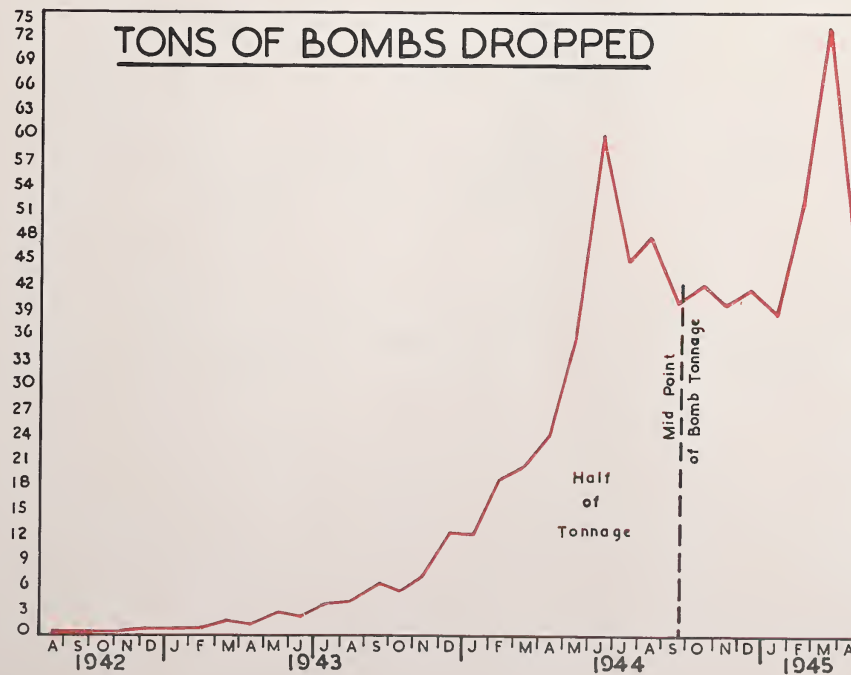
disruption for the Eighth Air Force. But the only attempts to carry such an attack were made too late in the war and with too little force.

The mobility of his force was high. Units were shifted from base to base, and even the base units were capable of rapid redeployment.

Flexibility of the enemy air force was high, largely because of the nature of his control system and because of the fact that his operations were over his own territory.

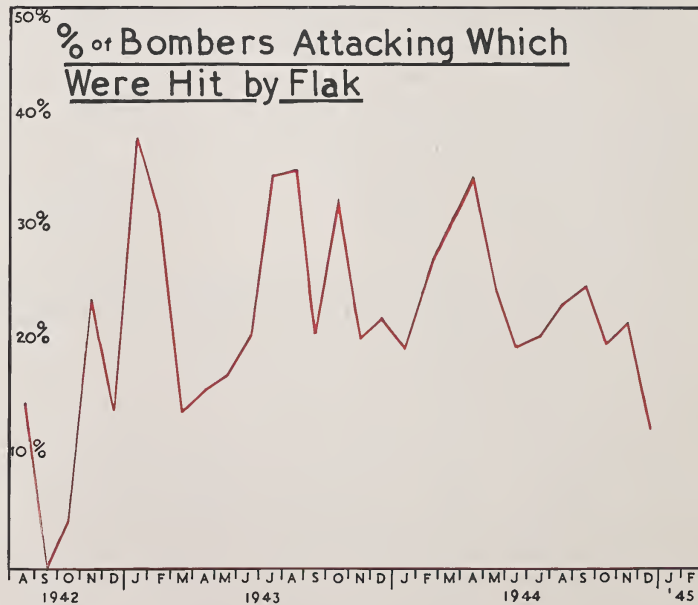
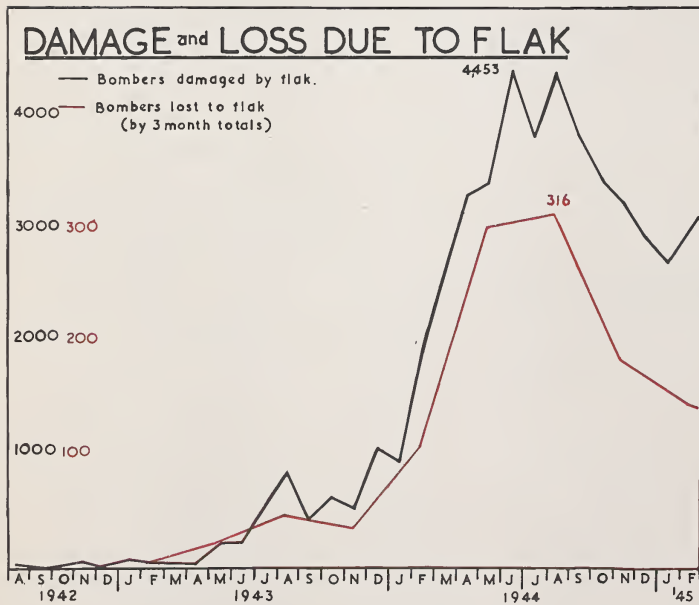
But flexibility in employment of German fighters was in some instances over-done.

Fighters trained and experienced in attacking bombers were redeployed as ground attack units. Units experienced in the fight on the Eastern Front were sent to the Western Front into an entirely different type of operation. Valuable experience gained at great cost, thus, was wasted almost entirely.



PERCENTAGE DISTRIBUTION OF EIGHTH AIR FORCE BOMBS

1 SEPTEMBER 1944 - 31 DECEMBER 1944 (EXCLUSIVE OF THREE ATTACKS IN CLOSE COORDINATION WITH GROUND FORCES)



APPENDIX A
DEVELOPMENT
OF THE
ORGANIZATION

THE MOVE ACROSS

Four days after Pearl Harbor, Germany declared war on the United States. This act brought down upon German industry and on all other sources of supply and replacement of the German Armed Forces, the most concentrated air assault in military history. When this combined air offensive was decided upon at a joint meeting of the British and American chiefs of staff, its purpose was determined to be:

- (1) to gain air superiority over the German Air Force in order to make possible Continental invasion, and
- (2) to weaken fatally the enemy's military economic and industrial capacity to wage war.

To fulfill America's part in this mission it was decided to mount 52 heavy bombardment groups and 56 fighter groups, activated in America, but operationally trained in and launched from the British Isles against Fortress Europe. On 28 January 1942 at Savannah Army Air Base, Georgia, the first in a series of historic milestones was reached with the activation of Headquarters and Headquarter Squadron, Eighth Air Force, and Headquarter Squadron, Eighth Air Force Base Command (later Eighth Air Force Service Command).

Under command of Lieutenant General (then

Brigadier General) Ira C. Eaker (appointed 31 January 1942) preparations were speeded to carry out the proposed offensive mission and shortly thereafter Headquarters of Eighth Bomber Command (activated 23 February 1942) was established in Great Britain. The Eighth Ground Air Support Command was activated on 28 April 1942 at Bolling Field, Washington, D.C. The Eighth Transport and Eighth Air Force Composite Command were planned but not yet activated.

Problem one, naturally, was personnel. To meet this pressing need, an echelon consisting mostly of personnel officers was innovated at Bolling Field, Washington, D.C. in May 1942. This echelon interviewed, selected and indoctrinated key staff officers, then moved them to the British Isles via Fort Dix, New Jersey, where an Eighth Air Force echelon was located exclusively for processing personnel en route to the United Kingdom. As the personnel problem developed in scope Army Air Forces created its own embarkation echelon still at Fort Dix, to replace the Eighth.

General Eaker and his staff applied themselves initially to meet three needs:

- (1) mounting a bomber offensive against German occupied Europe in conjunction with the Royal Air Force,

- (2) initiating fighter operations in conjunction with the Royal Air Force, first in defense of the British Isles and later to escort daylight bombers,
- (3) logistical supporting of the forces required to meet the first two needs.

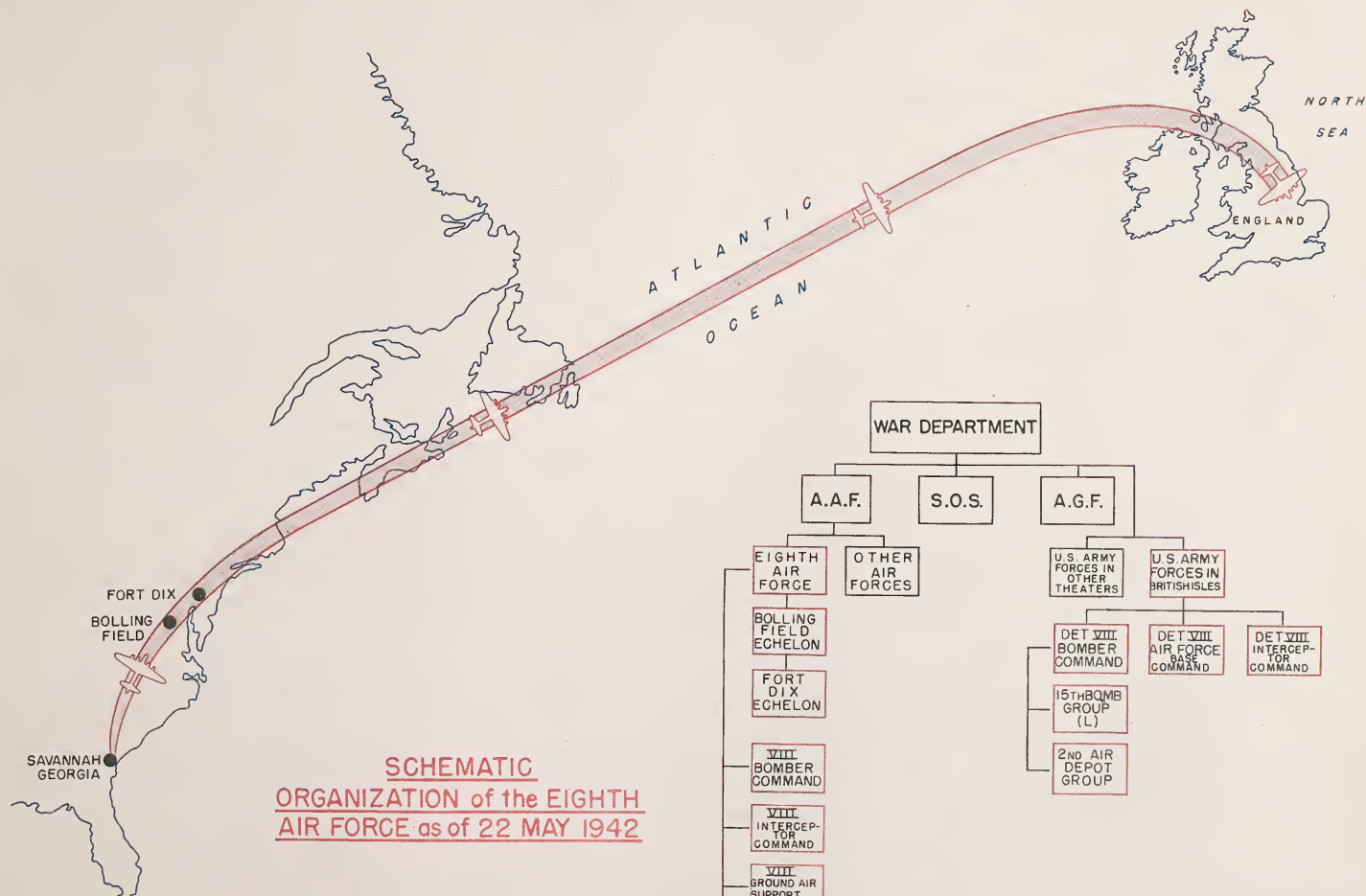
Necessity was the basic principal which governed the meeting of these needs. With only limited resources available, the most essential commands were activated first, namely, Eighth Bomber Command; Eighth Base Command (later Eighth Air Force Service Command); and Eighth Interceptor Command (later Eighth Fighter Command).

Under the impetus of the first two of these Commands, a minimum organization was framed in the United Kingdom controlling bomber operations and supply. Then, secondary organizational problems were tackled relating to rendering operational fighter, training, and transport commands.

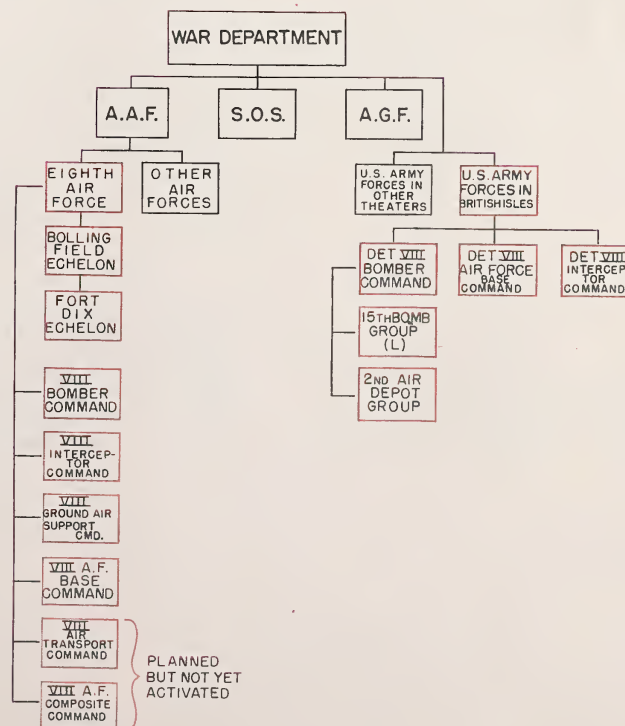
On 22 May 1942 the first Eighth Air Force combat unit arrived for operational training. Eighth Air Force was then ready to enter the second phase of its organizational development.

22 MAY 1942

CHART No.1



SCHEMATIC ORGANIZATION of the EIGHTH AIR FORCE as of 22 MAY 1942



GROWING PAINS

On 17 August 1942 twelve B-17s of the 97th Bomb Group departed from Polebrook Airfield in East Anglia, bound for Rouen, France, 200 miles away. There they aimed and dropped 17 tons on enemy runways and returned to their home base without loss. Successfully they had accomplished the first independent mission over German-occupied Europe by Eighth Air Force heavies.

Rouen was a memorable and promising mission. Memorable, because it marked the Eighth's giant stride from a skeleton air force of four commands into an operational complex of six major commands, two of which--Eighth Bomber and Eighth Air Force Service Commands---were firmly established in adequate headquarters installations with at least the minimum personnel and tools required to perform their mission. Promising, because it forecast the shadow of increased striking power in the months of expansion ahead.

Comparison of Chart #2 with Chart #1 reveals immediately the tremendous physical progress achieved by the Eighth since its establishment on British soil three months previous.

Eighth Interceptor Command had now been redesignated Eighth Fighter Command with permanent headquarters controlling elements of four fighter groups. Despite aircraft shortages

due to transport difficulties, the temporary procurement of Spitfires from the cooperative Royal Air Force, which also furnished operational and maintenance training aids, contributed to development.

Designed to work in close cooperation with invasion troops, Eighth Ground Air Support Command had now acquired limited headquarters personnel and one assigned group, the nucleus for an expanded medium bomber force later transferred wholesale to Ninth Air Force.

Two new commands were added. Eighth Troop Carrier Command (Provisional) was organized to participate in the anticipated early invasion of Europe, while Eighth Air Force Composite Command, an outgrowth of the originally contemplated Northern Ireland Command, was charged with receiving and training incoming tactical groups, encompassing responsibility for Northern Ireland as well. The latter had only seven officers and four enlisted men at the time.

The B-17s which hit Rouen hailed from the only heavy bombardment group in the theatre, which was assigned to the 1st Bombardment Wing. Now in anticipation of the arrival of new groups two heavy bombardment wing headquarters were established under Headquarters Eighth Bomber Command. It was intended at this time to make these wings into complete operational and

administrative headquarters with eventual control of up to fifteen heavy bombardment groups.

That first Rouen mission was supplied by a patchwork pattern of temporary measures. Few service units had arrived during the two months in which the Eighth Air Force Service Command had been functioning in the theatre. From the Royal Air Force had come practically all the non-technical supplies. Space had also been obtained at two Royal Air Force depots for storing and issuing United States Army Air Force supplies, but there was much spade work to be done before fully functioning depots of the Eighth Air Force Service Command could be established.

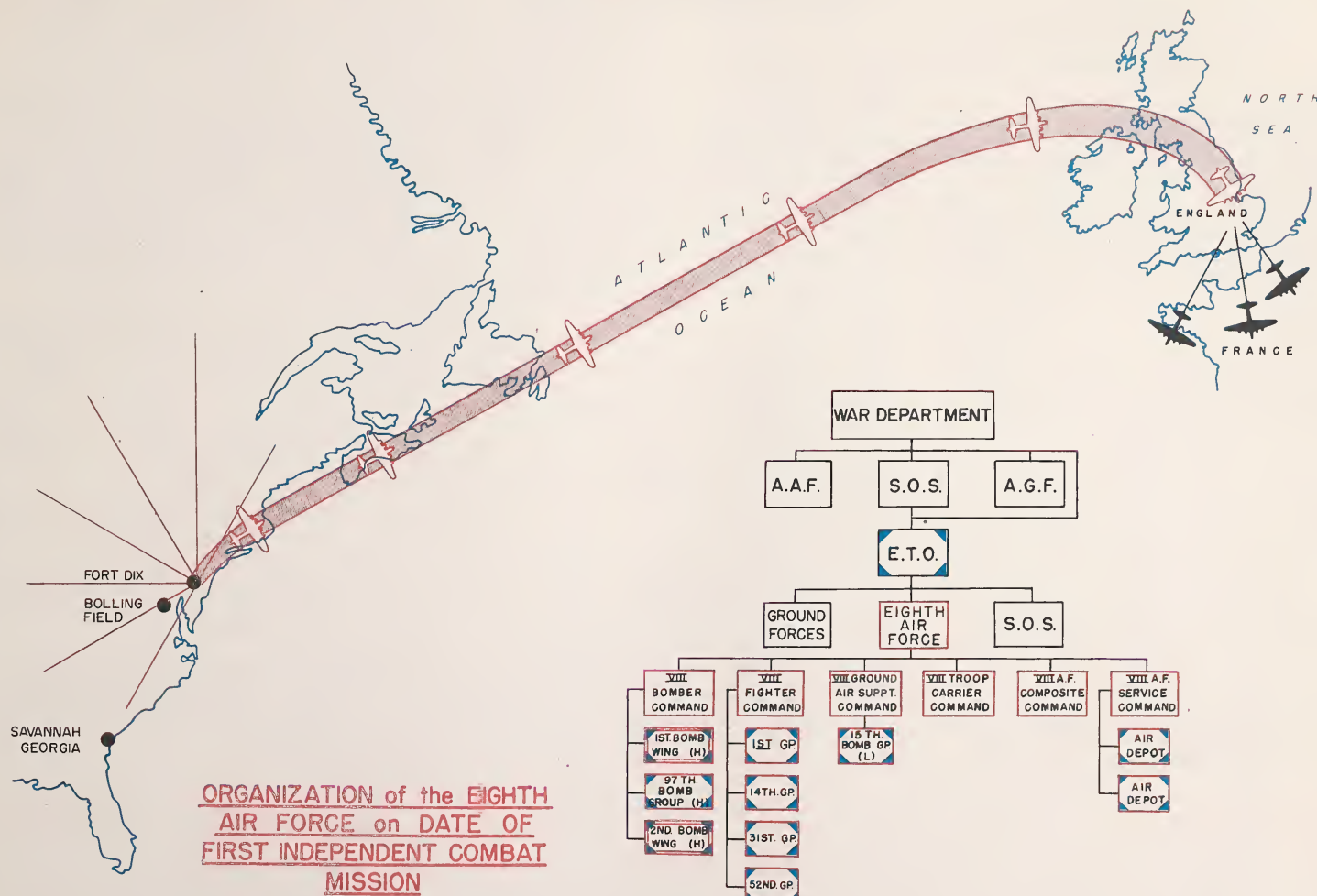
Thus Rouen demonstrated to General Eaker and his staff that there must be an accelerated follow-up. With all possible rapidity he and his staff concentrated on three major problems:

- (1) expansion,
- (2) adequate provision for combat crew training in the United Kingdom,
- (3) organization of the flow of supplies from the ports and United Kingdom sources to Eighth Air Force units.

Chart #3 reveals what they accomplished.

17 AUGUST 1942

CHART No. 2



— EIGHTH AIR FORCE ORGANIZATION
— NEW UNITS

THE FIRST 1000

Before Eighth Air Force could begin reducing the strength of the Luftwaffe it was called upon to help in the elimination of the U-boat menace during the period September 1942 to May 1943. This campaign saw the bombing of the German submarine pens and U-boat production centers and concurrently the rapid expansion of Eighth Bomber Command. Four of the projected bombardment wings had now been established and three were operational.

Meanwhile, the decision of the Joint Chiefs of Staff to invade Africa diverted emphasis from the original invasion plans and simultaneously effected the structure of the Eighth. Eighth Air Support Command was left without a mission and, until taking over medium bombardment, its development was naturally slow.

Eighth Air Force Composite Command suffered similarly from tactical and operational changes. Originally, substantial commitments of the Eighth to Northern Ireland had been reduced for two reasons: (1) the reduction in the enemy threat to Northern Ireland which eliminated earlier plans for stationing operational fighter groups there, and (2) the unsuitability of Northern Ireland as a training base for bomb groups.

The Commanding General, Eighth Bomber Command, insisted on training establishments nearer to the tactical stations and the other major installations in England. As a result,

a Combat Crew Replacement Center was established directly under Eighth Bomber Command; thus the Eighth Air Force Composite Command's training function was never fully realized.

The U-boat campaign with its shorter Western France and North Sea targets enabled Royal Air Force Spitfires to provide escort for the bomb groups then operating. Hence Eighth Fighter Command, although retaining its original mission, developed less swiftly than Bomber Command. In order to mount a great striking force, heavy bombardment groups were given precedence over fighters in movement of tactical units to the theatre. Nevertheless the Eighth Fighter Command established two Wings with complete operational and administrative headquarters. It possessed its own training unit and a gunnery and tow target flight, entirely separate from the Northern Ireland training command under the Eighth Air Force Composite Command.

One of the main reasons why the Eighth was able to lend assistance to the reduction of tonnage sunk by U-boats -- from 700,000 to 100,000 per month by May 1943 -- was because many of its major supply problems had been solved. Three advanced air depots established in southeast England had been integrated into an advanced service organization under Headquarters Advanced Air Service (later Headquarters Strategic Depot Area). The trickle of supplies nine months previous had now become a gusher of

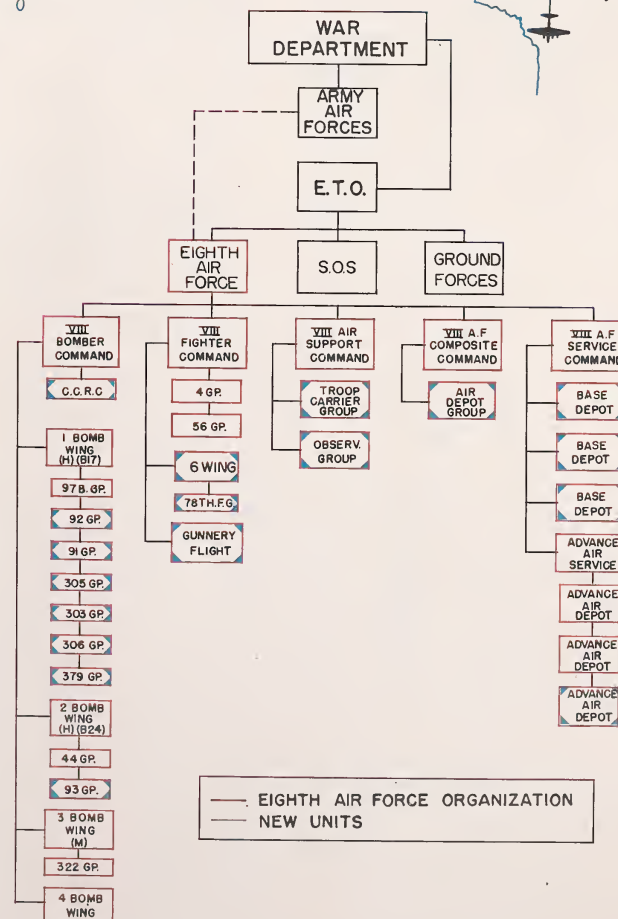
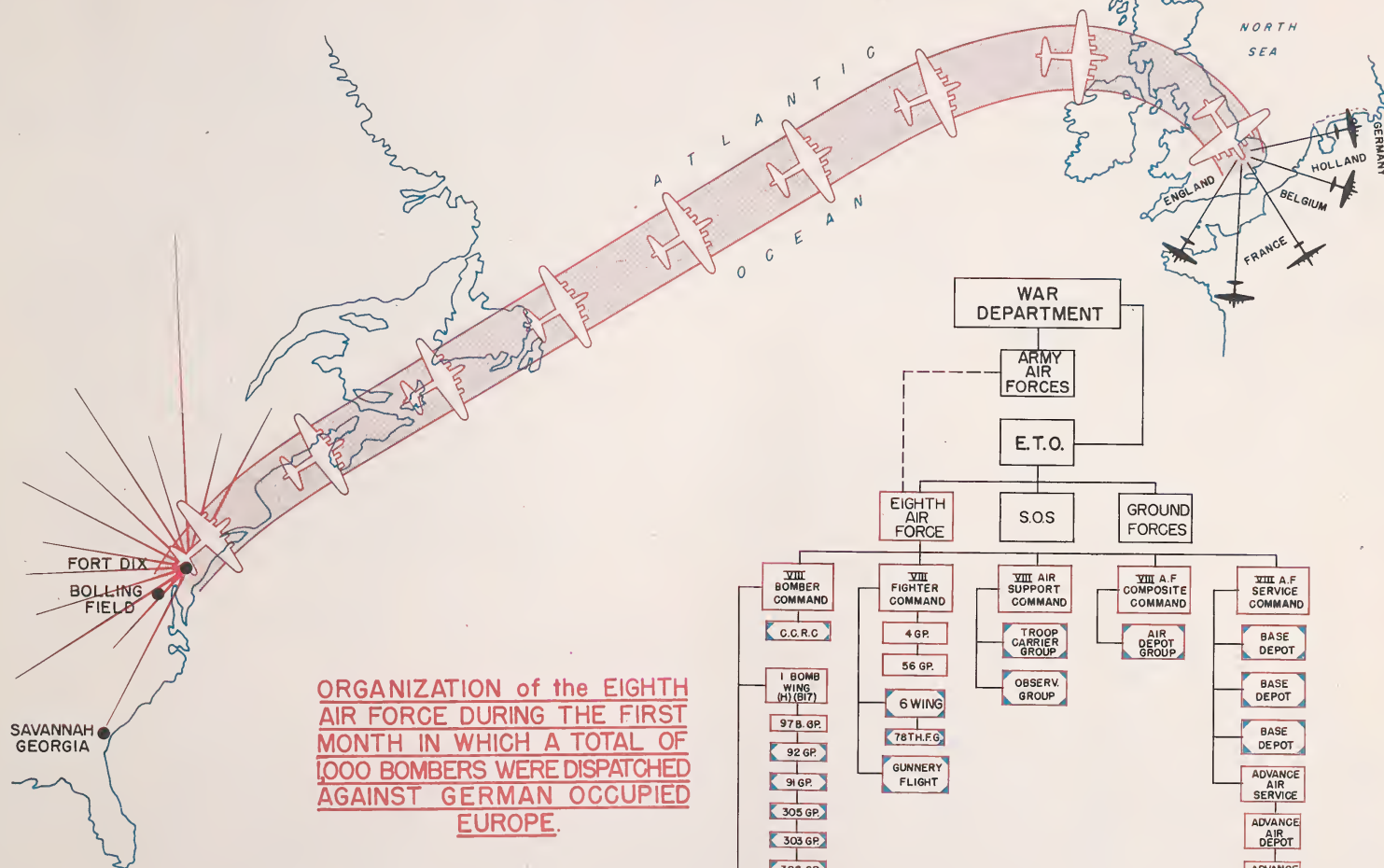
resources for tactical stations. By placing supply depots within easy reach of tactical groups and by establishing intimate daily contact between them and fourth echelon supply and maintenance organizations, Eighth Air Force Service Command (formerly Headquarters Strategic Depot Area) made it possible for 1,000 heavy bombers to be airborne during the month of May 1943, the first time in the history of the Eighth.

During that May, a twelve-months campaign was launched against German aircraft industry and the Luftwaffe. However, there appeared problems while the campaign was continuing:

- (1) the need for an intermediate operational control between the bomb wing and the bomb group,
- (2) the unsatisfactory system of operating both heavy and medium bomb groups under a single command,
- (3) the need for further organization of supply channels and responsibility between the base and advanced supply organizations,
- (4) the unsatisfactory development of Eighth Air Force Composite Command and Eighth Air Support Command in the light of the changed tactical situation.

10 MAY 1943

CHART No.3



SET- UP

Flexibility was the keynote of Eighth Air Force organization. General Eaker and his staff built without precedent; similarly, they could break it when the occasion demanded. With "the first 1,000" in their grasp they paused to examine the complex organization of the basic unit.

Army Air Force Regulation 65-1, 14 August 1942, decreed complete separation of the service and tactical units and their functions. Tactical units were to be located on dispersed airdromes and receive third echelon supply and maintenance from a Service Centre. This Service Centre, manned by a Service group and associated units operating under the command of Air Force Service Command, was to be located on its own airdrome adjacent to the tactical airdromes it would serve.

This form of organization was considered impracticable for air force operations in the

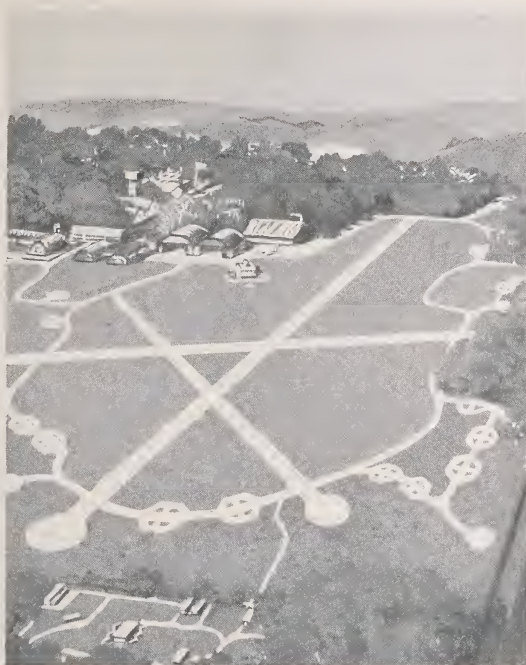
United Kingdom. First, because of labor, materials, and land space shortages in the United Kingdom, the number of airdromes that could be constructed within a reasonable length of time was insufficient to provide separate establishments for service and tactical units. Second, since it was necessary to establish service and tactical units on the same station it was essential that all units on the station should be under one commander - the tactical commander.

Upon arrival in the United Kingdom a service group consisting of an Headquarters and Headquarter Squadron Service Group and two Service Squadrons were divided into two parts, equal, insofar as possible, in personnel and equipment. One-half of the Headquarters and Headquarter Squadron Service Group and one of the Service Squadrons were assigned to a tactical station to support a full bombardment or fighter group. The other half and its

accompanying Service Squadron were assigned to another group.

Within reasonable limits, the station commander was free to prescribe his own functional organization because all the required service units were not always available for a standard one. Consequently variations in the line organizations of different stations were inevitable. Chart #3 (a) expresses in theory the organization of a typical Air Force station at the time Eighth mounted its first 1,000 bomber assault.

The flexibility which existed in its highest echelon permeated down to Eighth's basic units. Upon arrival in the theatre, commanders and personnel were quick to adjust themselves to this new plan. No major difficulties were experienced at any time and it continued as a standard of station organization until the day Germany capitulated.



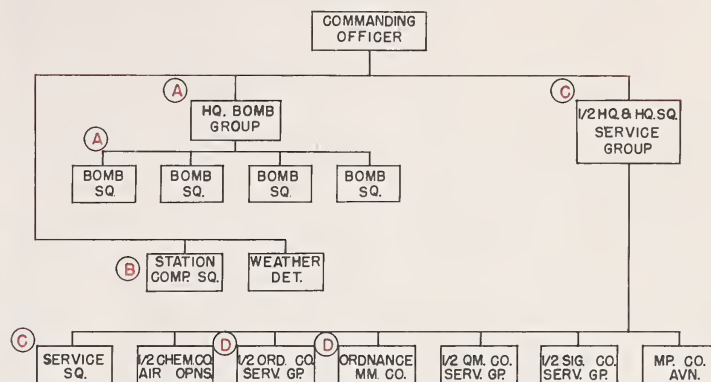
TYPICAL U.S. AIRDROME
IN THE UNITED KINGDOM

**STATION ORGANIZATION
(TYPICAL)
SHOWING COMMAND AND
LINE ORGANIZATION IN
THE SPRING OF 1943**

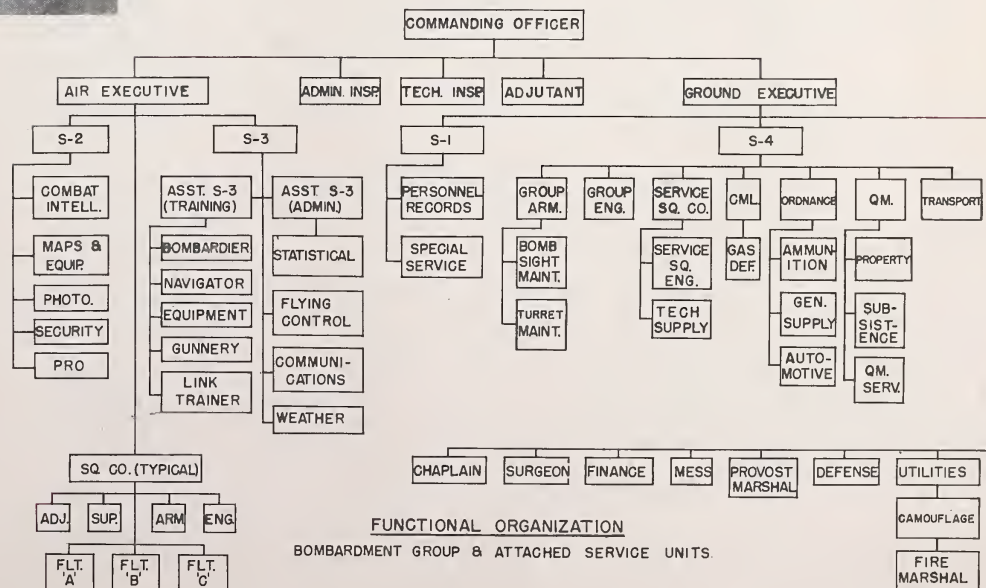
10, MAY 1943

LINE ORGANIZATION

CHART NO 3A



- (A) OR FIGHTER
 (B) PROJECTED ONLY - NOT ASSIGNED UNTIL AUGUST, 1943.
 (C) LATER REPLACED ON BOMBER STATIONS ONLY BY SUB-DEPOT.
 (D) LATER COMBINED TO FORM ORDNANCE S & M COMPANIES OF WHICH ONE WAS ASSIGNED TO EACH TACTICAL STATION AS AVAILABLE



FUNCTIONAL ORGANIZATION

BOMBARDMENT GROUP & ATTACHED SERVICE UNITS

INTERNAL STREAMLINING

Allied landings in North Africa and the subsequent rout of Rommel's forces paved the way for invasion of Sicily and Italy. Meanwhile in the European Theatre of Operations, Eighth Air Force in conjunction with the Royal Air Force, was establishing supremacy over the Luftwaffe.

During this period the relation of Air Force Headquarters to the Theatre Headquarters remained unchanged as did the designation of Eighth's major subordinate commands. However, three significant internal changes did take place:

- (1) Eighth Bomber Command was relieved of its medium bombardment wing and subsidiary medium groups, thus becoming exclusively a heavy bombardment command,
- (2) addition of a reconnaissance group and an anti-submarine group under direct control of air force headquarters,
- (3) establishment of base and advance service areas, each area having its own headquarters under Eighth Air Force Service Command.

The postponement of the European invasion and the shift in emphasis to Italy negated the original mission of Eighth Air Support Command, i.e., furnishing close cooperation for ground operations. For the first time since its establishment in the United Kingdom late in July 1942, Eighth Air Service Command acquired, with assumption of medium bombardment responsibility, an important operational and administrative mission. Receipt of the 3rd Bombardment Wing (Medium), transferred intact from Eighth Bomber Command also gave Air Service Command an experienced intermediate headquarters

between the Command and the groups and allowed medium bomber operations to proceed without serious interruption.

The U-boat and Luftwaffe campaigns had created the need for two highly specialized groups - Anti-Submarine and Reconnaissance - both of which were added during this period. When expansion in Royal Air Force Coastal Command was sufficient to cope with the submarine menace, the Anti-Submarine Group was transferred, but Reconnaissance grew in importance.

Supply, too, underwent marked expansion. Eighth Air Force Service Command realized the need for decentralization and established a headquarters for its base depots in addition to opening a fourth advanced depot under Headquarters Advanced Air Service (redesignated Headquarters Strategic Air Depot Area). Coincident with these changes, Headquarters Base Air Depot Area was delegated broad responsibility for the supervision of activities in both Base and Strategic Air Depot Areas. Eighth Air Force Service Command could then confine itself more and more to the establishment of overall plans and procedures.

Implementation of Eighth Air Force Composite Command's training mission lagged, mainly because it was found possible to train bomber crews in the tactical areas under close supervision of Eighth Bomber Command. Eighth Air Force Composite Command established one combat crew replacement center where it trained fighter pilots. This training center was shared with the gunnery school of Eighth Fighter Command, which was rapidly expanding.

Several fighter groups were rushed into the theater when unescorted bombers began to feel interception attacks of the Luftwaffe. Although the basic organization of Eighth

Fighter Command was unchanged, its organizational framework filled rapidly.

The accelerated tempo of the air war over Europe caused by the invasion of Italy on 3 September 1943 found the basic organization of the Eighth Air Force virtually complete. Yet several major organizational problems remained:

- (1) the number of heavy bombardment groups assigned to the wings was too large for adequate operational control by one headquarters, whereas a single headquarters was adequate for the administration of these groups;
- (2) an increasing need was being felt for a reconnaissance headquarters. Need not only to coordinate the reconnaissance operations of the photographic group, but also to enable the Air Force to print, interpret and distribute the vast amount of target and other operational photographs required by the air forces as well as theater headquarters. At this stage the work was being done largely by British agencies. Not only did the increasing volume strain the British facilities, but lack of facilities and personnel to do this specialized job within Eighth was considered a serious shortcoming to its self-sufficiency;
- (3) establishment of the 9th, 12th and 15th Air Forces in Africa and Italy within bombing range of Fortress Europe created the need for coordinated operational control of these air forces with that of the Eighth.

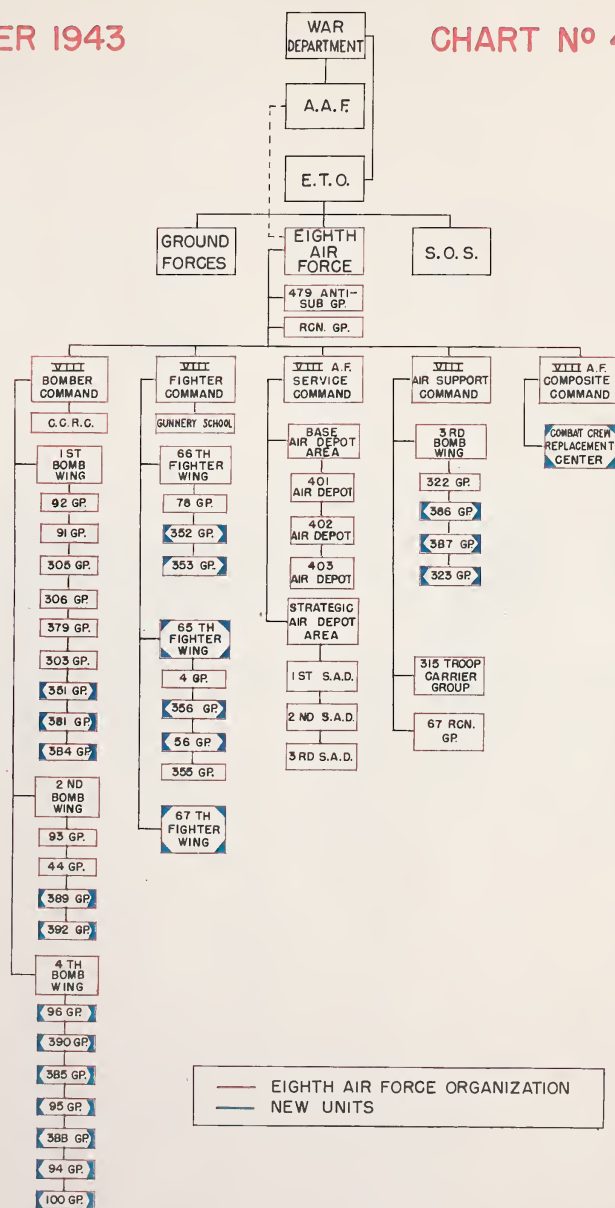
Chart #5 shows how these problems were met.

5 SEPTEMBER 1943

CHART N° 4



ORGANIZATION of the EIGHTH AIR FORCE AT TIME OF THE INVASION OF ITALY



— EIGHTH AIR FORCE ORGANIZATION
— NEW UNITS

TUNING UP FOR INVASION

The pendulum of invasion was swinging from Italy back to Northwestern Europe where air power was in the process of softening-up the enemy. The Eighth and the Royal Air Force, operating from the United Kingdom, were being augmented.

To meet the need for single operational control of the strategic Eighth and Fifteenth and to coordinate inter-air force problems, United States Strategic Air Forces in Europe was established on 6 January 1944 under General Spaatz. This came one week after General Eisenhower was named Supreme Commander of the European Theater of Operations and Lieutenant General (then Major General) James H. Doolittle succeeded General Eaker as Commander of the Eighth. General Eaker moved to Africa to become Commander of the Mediterranean Allied Air Forces.

Concurrently the Ninth Air Force was moved from the Mediterranean to the European Theater of Operations and took form as the "invasion" air force while United States Strategic Air Forces in Europe under Headquarters European Theater of Operations exercised operational control over the Eighth and Fifteenth Air Forces and administrative control of all United States Air Force Commands in the United Kingdom.

These moves produced significant changes in the Eighth. The formation of United States Strategic Air Forces in Europe utilized a large proportion of the personnel from this Headquarters, as did transfer of Eighth Air Support Command and Headquarters Eighth Air Service Command to the Strategic Air Depot Area. The latter was redesignated Headquarters Air Service Command, United States Strategic Air Forces in Europe, and its control of the Base Air Depot Area remained basically unchanged.

Headquarters Eighth Air Force moved to the installation of Headquarters Eighth Bomber Command, absorbing the personnel and functions of that inactivated headquarters. This elevated the bombardment divisions formerly under Eighth Bomber Command to major subordinate commands operating directly under the Air Force Headquarters.

Subsequently, Strategic Air Depot Area became Headquarters Eighth Air Force Service Command without changing its basic organization and mission. However, its personnel and facilities were progressively enhanced to meet increased supply and maintenance requirements stemming from an expanding air force.

To make Eighth self-sufficient from a reconnaissance standpoint, the 8th Reconnaissance

Wing (Provisional) was organized on 18 February 1943, supervising the operations of the photographic group already assigned (see Chart #4). This new organization could print, interpret and distribute the vastly increased number of target and other operational photographs required.

To bolster the function of Eighth Air Force Composite Command, it received control of all theater training of Eighth Air Force units. Whereupon, the Command Headquarters moved from Northern Ireland to the Eighth's area in England. All training units assigned to the bomber and fighter commands were reassigned to Eighth Air Force Composite Command as well as certain miscellaneous tactical groups such as Eighth Fighter Command's gunnery and tow target flights.

The flow of fighter groups to this theater continued during this "tuning up for invasion" period. Escort range increased as Eighth's fighters added auxiliary gas tanks. The climax came in the last week of February 1944 when the combined impact of the Eighth and Fifteenth, striking together at the industrial vitals of Germany's aircraft industry, damaged severely the Luftwaffe source of aircraft supply.

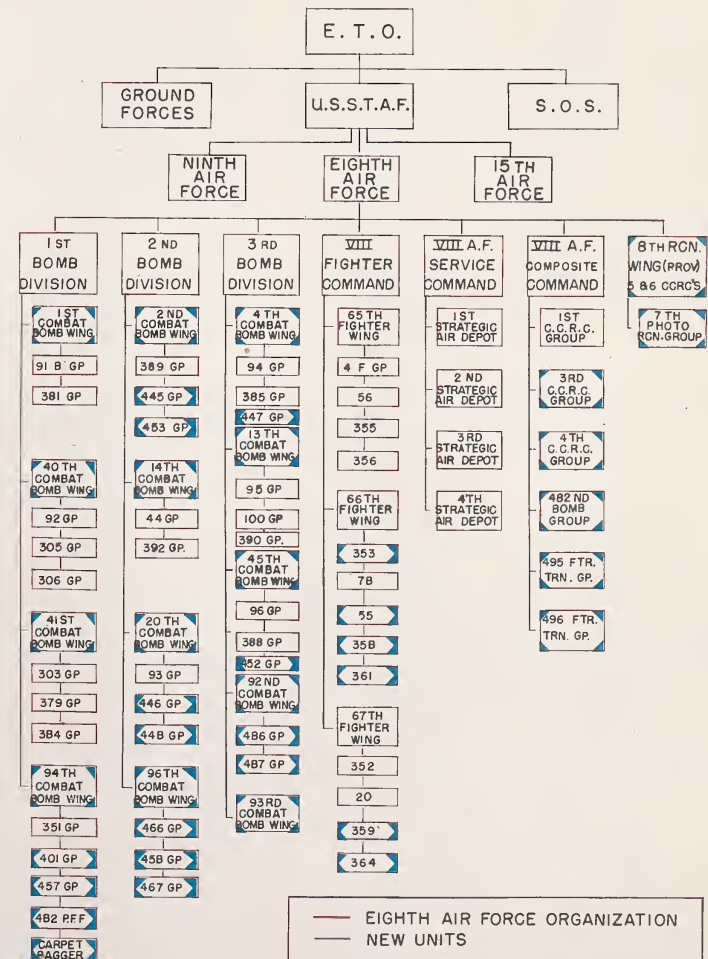
All was then in readiness for Invasion.

6 MARCH 1944

CHART N° 5



ORGANIZATION of the EIGHTH
AIR FORCE AFTER FORMATION
OF U.S.S.T.A.F. IN PREPARATION FOR
CONTINENTAL INVASION



INVASION AND VICTORY

"If you see any planes they will be ours," General Eisenhower told his invading forces. This was the tribute he paid to the effectiveness of the Eighth Air Force and Royal Air Force against the Luftwaffe. Guarded by a phalanx of fighters while bombing neutralized enemy defenses, Allied invading forces seized toe-holds on the beaches, linked up their bridgeheads and eventually over-ran Northern France.

Its softening-up and invasion tasks completed, Eighth Air Force could then concentrate wholly on its Casablanca directive, "the progressive destruction and dislocation of the German military, industrial, and economic system to a point where the capacity for armed resistance was fatally weakened".

While this job was being accomplished, substantial organization changes took place, some the result of invasion, others calculated to inject more flexibility into the operational set-up.

The bomb divisions then became in effect "little air forces," each with assigned control over a fighter wing. To complete the organization, each bomb division received the sub-depots and strategic air depots servicing it and became an Air Division complete with bombers, fighters and services. This anticipated future transfer of Air Divisions intact to other theatres if necessary. It also increased the versatility of the Eighth Air Force, preparing it for the numerous changes that the tactical situation would present.

As in the transfer of the medium bombers to the Eighth Air Support Command (see Chart #4)

complete units in the form of fighter wings were transferred to the Bomb Divisions. Each wing comprised five fighter groups together with the administrative and operational headquarters. In this way operations could continue with a minimum of disruption. Operationally the fighter wings remained on a level with the combat bombardment wings already operating under the bomb divisions. But administratively the fighter wing paralleled the bombardment group, since the combat bombardment wings had no administrative function. While this interposed an intermediate headquarters between fighter groups and air divisions in contrast to the direct channels of the bomber organization, the air divisions benefitted by the previous experience of the fighter wing in supplying and administering the fighter groups.

Following the fighter transfer, attention was focussed on Eighth Air Force Composite Command, whose training function, never fully realized, was then even less needed. All the combat groups scheduled for the European Theatre of Operations had at that time arrived and training activities, which the air divisions were in a position to handle, involved only replacement crews. Moreover, a need existed for a command to supervise training for disarmament of the Luftwaffe after Victory in Europe Day. For these reasons United States Strategic Air Forces in Europe requested the release of Composite Command and four of its Combat Crew Replacement Centre training groups. Upon completion of the release, the Eighth Fighter Command (moved later to the Continent) absorbed the miscellaneous responsibilities of Composite Command.

In August 1944, Eighth Reconnaissance

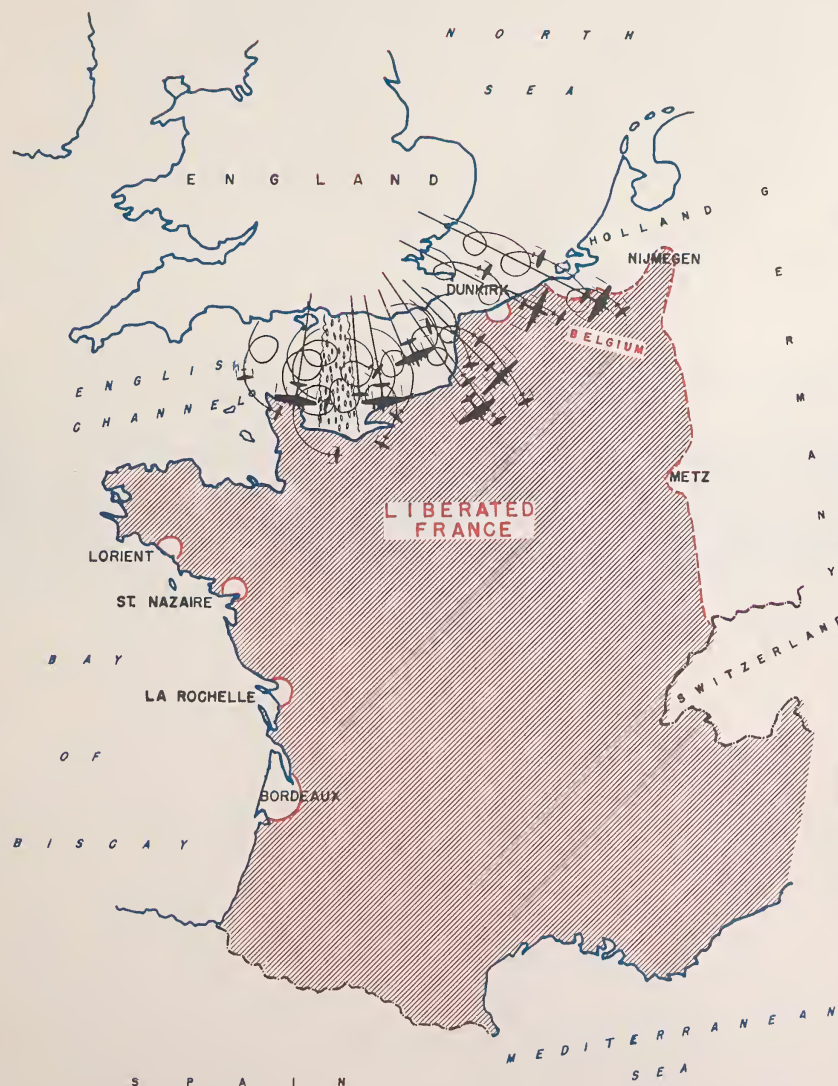
Wing (Provisional) was reorganized into 325th Photographic Wing Reconnaissance. In addition to its varied duties of photographic reconnaissance and the printing, interpretation, and distribution of target and operational photographs, the wing assumed responsibility for the 802nd Bombardment Group (Special) Provisional. This group performed special light and heavy weather reconnaissance. From time to time the 325th undertook special assignments for the ground forces in Europe before and after the invasion and consequently underwent regularization and amplification as the need arose.

After the liberation of most of France it became possible to recover and return to the United Kingdom or salvage large numbers of Eighth Air Force aircraft. Previously, when required to land on the Continent, these aircraft had been written off. Establishment by Eighth Air Force Service Command of a Continental echelon made possible proper supervision of their salvage and return. The echelon began work in August 1944, consisting at first of mobile reclamation and repair squadrons and personnel on temporary duty, then eventually expanding into Eighth Air Force Service Command Centre. Later this became Headquarters Eighth Air Force Service Command (Advance) and the Fifth Strategic Air Depot.

With this organization Eighth Air Force flew the record mission of 24 December 1944 when over 2,000 bombers were dispatched accompanied by over 900 fighters. With this organization Eighth Air Force helped to destroy the German oil industry, the Luftwaffe, and played a major part in the victorious advance of our armies across Germany ending in final capitulation and Victory in Europe Day.

1 OCTOBER 1944

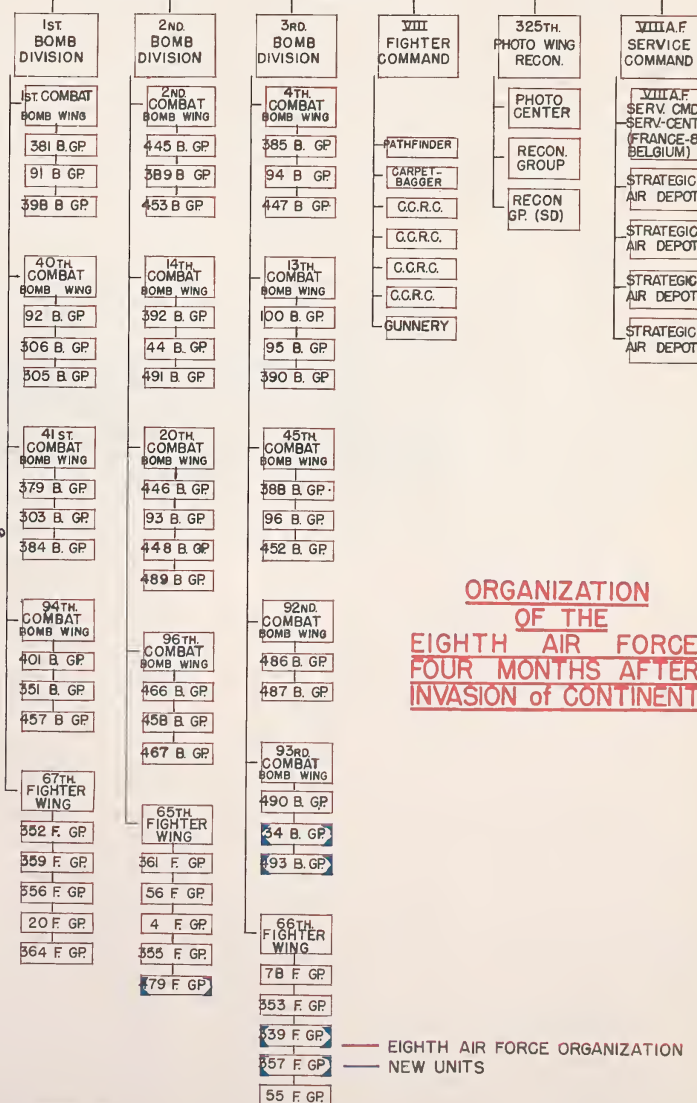
CHART N° 6



GROUND FORCES

EIGHTH AIR FORCE

S.Q.S.



ORGANIZATION OF THE EIGHTH AIR FORCE FOUR MONTHS AFTER INVASION OF CONTINENT

— EIGHTH AIR FORCE ORGANIZATION
— NEW UNITS

APPENDIX B
MAJOR MODIFICATIONS
TO AIRCRAFT AND
EQUIPMENT

CHANGE FOR THE BETTER

No matter how perfect the combat plane is when it rolls off the assembly line, its manufacturers cannot possibly anticipate all the requirements of combat. As the need arises modifications must be made.

Following is a tabular summary of the significant modifications of tactical importance made in aircraft arriving in this theater or as requested by the Eighth Air Force.

These modifications are considered in the light of combat requirements, and how these were met after the modifications were installed. Did they increase the performance and striking power of the aircraft? Did they add to its safety as well as to that of its flying personnel?

Modifications affecting armament, performance, safety, navigation, bombing devices, armor, communications and signals, and personnel equipment are considered in this table.

BOMBER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
<u>ARMAMENT</u>				
B-17	Twin .50 calibre nose gun installations mounted in center of nose compartment over bombight	January - March 1943	The only available forward fire power came from the top and ball turrets. The Luftwaffe made successful head-on attacks by exploiting the vulnerability of this blind spot	Both installations were mounted locally in the European Theater of Operations pending arrival of aircraft equipped with chin turrets, which were effective in discouraging head-on attacks
B-17	Twin guns superceded by single gun mount	March - April 1943	To increase azimuth travel and facilitate handling of gun	
B-17	Waist gun relocated to a position nearly level with fuselage	February 1943	The production mounts of the waist guns were located approximately 6 inches inside the skin line of the fuselage. This greatly reduced the field of fire due to the limited size of the open waist window	The modification, which was carried out in the European Theater of Operations, allowed a greater azimuth swing and greater downward deflection of the waist guns
B-17	Capacity of waist gun ammunition cans increased to 600 rounds	February 1943	Former capacity only 200 rounds	Both this and previous modification incorporated in production aircraft
B-17	N-8 optical gunsight installed in tail position	July - August 1943	Requested during Spring of 1943 to increase effectiveness of tail position	Incorporated in production aircraft and proved very satisfactory in conjunction with 90-degree cone of tail gun fire
B-17	Metal tail enclosure modified to give 90-degree cone of fire	August 1944	Azimuth movement of the tail guns was restricted. As a result, the frequency of enemy tail attacks increased	Increased field of fire was effective in warding off frequent tail attacks
B-17	Sperry K-13 sights replaced the "iron" sights	September 1944	By that time, waist guns only guns on B-17 having mechanical wing and bead type sights	Sufficient Sperry K-13 sights were received from the United States to equip combat aircraft
B-17	Proposed removal of both chin and ball turrets	April 1945	Infrequency of enemy fighter opposition plus subsequent increase in range, altitude, and performance	Proposed by some bombardment groups but war ended before proposal could be thoroughly considered

BOMBER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
B-24	Twin .50 calibre nose gun mounted over bombsight	Early 1943	Need for frontal fire power as well as mid-ship and downward fire protection	Twin nose gun installed in European Theater of Operations prior to entry into combat
B-24	Consolidated and Motor Products nose turret superceded twin .50 calibre nose gun	November 1943	To add frontal protection	Installation effective until arrival of Consolidated and Motor Products nose turret, which gave good frontal fire power but materially affected flight characteristics
B-24	Experimental tunnel gun installations added to some B-24s	January - March 1943	To add downward fire power	Installation made in many B-24s, but not universally adopted pending production installation of retractable ball turret
B-24	Retractable ball turret installed in production aircraft	Fall 1943		
B-24	Waist gun position relocated nearer to fuselage	Fall 1943	To increase azimuth of fire	Waist guns were the only guns remaining manually operated
B-24	Ball turrets removed in some B-24s	June 1944	Due to lack of enemy attacks from field of fire covered by ball turret guns	Increased performance
B-24	It was planned to install both K-14 and K-8 computing gunsights in tail turret of B-24s in the European Theater of Operations	April 1945	Interim measure pending arrival of production K-15 gyro-stabilized sights	War ended before this plan could be implemented
<u>RANGE</u>				
B-17 & B-24	Installation of Tokyo Tanks (series of nine auxiliary tanks built internally into wing tips)	November 1943	Bombers could not accomplish long range missions profitably due to inadequate fuel capacity. Bomb bay tanks had been carried, but these reduced the bomb load	The Tokyo Tanks increased fuel capacity and enabled the bombers to cover nearly all enemy territory then held

BOMBER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
<u>SAFETY</u>				
B-17	The life-raft release handle was placed outside the fuselage instead of in the radio compartment. This modification was made on all service and production aircraft	December 1943	Many crews were lost due to the aircraft sinking before the life-rafts could be released. Also, in order to release the rafts from the radio compartment one or two men were required to remain in the aircraft after it was ditched	This modification enabled any crew member to release the life-rafts from outside of the aircraft. This saved lives
B-24	Bomb-bays were cleared of miscellaneous equipment; canvas ditching ribs were installed to assist crew members in bracing upon ditching. Above this ditching station an auxiliary escape hatch was installed. Exclusive European Theater of Operations modifications were performed to increase egress	January 1944	The B-24 bomb-bay construction was unsatisfactory for ditching. Less time was available after a water landing than in the case of the B-17	Added to crew's safety
B-24	Life-raft enlarged in the European Theater of Operations and later adopted in production	January 1944	Life-raft compartment in production aircraft was too small to accommodate air/sea rescue equipment required in this Theater	Added to crew's safety
B-24	A thermal de-icing system superceded the rubber-boot system	Early 1944	To improve de-icing system and to reduce maintenance required	Hot exhaust gasses from engine nacelle area were ducted to all portions of the wing and tail assembly, proving very effective
B-17 & B-24	Outer wing panels were vented to exhaust the explosive vapors	September 1944	To prevent wing fires caused by the accumulation of combustible gasoline vapors	First developed by Fifteenth Air Force - later adopted by the Eighth Air Force, then put into production
B-17 & B-24	Attempts were made to purge fuel tank fires with inert gas	During 1943	To prevent fires	

BOMBER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
B-17 & B-24	Carbon dioxide-nitrogen or methyl bromide was used for extinguishing bomb-bay, wing, and Tokyo Tank fires	April 1945	To prevent fires	Prototype sent to Zone of Interior resulted in 30 kits being service tested
B-17 & B-24	Development of an exhaust gas-purging kit for extinguishing fires in wing tanks	April 1945	To lighten weight of aircraft and ease installation of gas-purging kit	Kit developed in the United States - a limited number of these kits to be tested in the United Kingdom in conjunction with nitrogen-purging prototype
B-17 & B-24	The Eighth Air Force requested investigation by Zone of Interior of a larger carbon dioxide cylinder and more dispersion on engine fire extinguisher	April 1945	Existing A-12 Engine Nacelle fire extinguisher proved ineffective. The capacity of carbon dioxide cylinder and the area covered by the dispersion ring were inadequate for combating engine fires in flight	War ended before the request could be carried out
<u>BOMBING</u>				
B-17	All-electric bomb release system replaced the manual lever. Also the A-4 release replaced the A-2 manual release. Both modifications made in production	Spring 1944	The manual salvo release handle proved unsatisfactory in operation at high altitudes due to the necessity of frequent cable inspection and adjustments	Modification satisfactory - reduced total weight of the release system
B-17 & B-24	The following navigation and overcast bombing aids were installed: a) H2X b) Gee-H c) Micro-H			An explanation of these aids can be found in Chapter III under "Overcast Bombing"
<u>ARMOR</u>				
B-17 & B-24	14 millimeter armor plate installed in various sections of the aircraft such as the instrument panel, navigator-bombardier's floor, pilot's compartment and waist positions	1943	To reduce casualties resulting from spent flak fragments penetrating the aircraft	Better protection afforded; casualties reduced

BOMBER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
B-17 & B-24	Development of a light "flak suit" to be worn by all crew members in conjunction with a lightweight flak-helmet	February 1943	To protect crew members from flak wounds	Suits were made of hard steel strips covered in a flexible canvas apron, sporan and back
B-17 & B-24	Flak curtains introduced as a substitute for armor plate	Late 1943 & Early 1944	To reduce the weight of aircraft	Flak curtains were hung in strategic areas of the aircraft and depended upon absorption of impact of the flak by the elasticity of the curtains
B-17	Service testing of 12 B-17s with heavily armored engines	1944	To protect engines from enemy fire	Unsuitable for operations because of reduced speed
<u>PERSONAL EQUIPMENT</u>				
B-17 & B-24	Introduction of a low pressure oxygen system which supplied oxygen to the mask only when the wearer inhaled	1943	To conserve oxygen, and prevent explosions and fires to which high pressure bottles were subject	Reduced oxygen consumption, and made system less vulnerable to attack
B-17 & B-24	The radio compartment hatch was closed over and the gun mounted in the plexiglass of the hatch. Subsequently closed waist windows were procured and the waist guns mounted in the plexiglass	1942-1943	To reduce the number of frost bite cases caused by the passage of drafts of cold air through the fuselage from the open radio hatch and waist windows	Frost bite casualties effectively reduced without reducing fire power
<u>SIGNALS AND COMMUNICATIONS</u>				
B-17 & B-24	One command transmitter of SCR-247N radio set was modified to limit R/T range to 10 miles for use in "Darky" system	Fall 1942	To aid lost aircraft in obtaining a more accurate fix	Later became a theater modification - technical bulletin covering it issued in February 1943

BOMBER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
B-17	British Standard Beam Approach equipment	Fall 1942	To aid approach in conditions approaching zero visibility and low ceiling	Met needs until improved equipment arrived from the United States
B-17 & B-24	SCS-51 improved on Standard Beam Approach by giving additional gliding angle	July 1944	To aid controlled approach during extremely poor weather conditions	This equipment easily procured because it was designed and produced in the United States
B-17 & B-24	Liaison radio equipment modified to allow tuning in of medium frequencies on a fixed antenna in 30 seconds	January 1943	Heretofore, bombers had to unreel a wire antenna in trailing fashion in order to tune in distress signals. It took too long to give an SOS	Later became a theater modification and aided in rescue of bombers in distress
B-17 & B-24	All bomber aircraft equipped with chaff-dispersing jammers; and special shutes installed to discharge this chaff or "window"	Fall 1943	To provide protection against enemy gun-laying radar	Shutes installed as a theater modification
B-17 & B-24	All aircraft except Pathfinder Force were equipped with two electronic jammers each and twelve aircraft of each group equipped with spot-jammers; later all aircraft except Pathfinder Force and spot-jammers equipped with triple "carpet" installations	Spring & Fall 1944	To provide protection against gun-laying radar by the enemy; to counter subsequent spreading of the enemy's gun-laying radar band in order to be able to jam effectively	Latter program of triple "carpet" installations not completed due to supply difficulties
B-17 & B-24	Small number of bombers equipped with an additional "Y" receiver and kits to cover frequencies used by the enemy R/T	April 1944	To increase the range of Ground "Y" by adding airborne "ears". To extend range of cover of enemy R/T traffic	All installations made by the bomb groups concerned. Airborne "Y" proved very effective in covering the Luftwaffe's movements
B-24	Marker Beacon radio bomb release installed as additional equipment for 2nd Air Division B-24s only	Began in March 1944	To enable all bombs in a formation to drop simultaneously with the leader's, and thus obtain a more compact pattern	Only two bombardment wings fully equipped because an improved system was being developed in the United States
B-17	Crawfish radio bomb release installed in 3rd Division bombers	Fall 1944	To add more frequencies for radio bomb release and eliminate interference	Designed and developed in the United States. War ended before entire air force could be equipped

FIGHTER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
<u>ARMAMENT</u>				
P-47 P-38 P-51	Introduction of the K-14 gyro gun sight	Late 1943 & Early 1944	To increase accuracy of gun fire	Adapted from the British Mark II gyro sight as used in bomber turret positions. The K-14 proved to be the most accurate sight installed in European Theater of Operations fighters
<u>BOMBING</u>				
P-38	The nose armament of some P-38s was removed and a plexiglass nose installed which allowed the carriage of a bombardier and bombsight in the nose position	Early 1944	To equip a number of fighter-bombers with bombsights for attacking strategic German targets	These P-38s became known as "Droop Snoots". They were used as lead airplanes for a formation of standard P-38s carrying bombs. This afforded a fast, high-flying formation of fighter planes carrying an unusually high bomb load for fighter aircraft. After the attack a formation of this type was able to act as its own fighter protection
<u>SAFETY</u>				
P-47 P-51	A modification in structure was to "blow" the canopy on either side of the pilot	March 1943	To increase both rearward and sideward vision necessary in taxiing and combat	Later production versions gave the pilot an unobstructed 360-degree vision
P-47	Later both P-47 and P-51s were equipped with production versions of "bubble" canopies			
P-47 P-51	Introduction and use of electrically heated gloves and spats	1943	To prevent frostbite caused by inadequate heating of fighter cockpits	A successful temporary measure. Later the installation of cockpit heating systems obviated this necessity
P-47 P-51	Installation of rear view mirrors	1944	To give the pilot a safety feature which warned him of rearward attacks without distraction from the performance of his other duties incidental to combat flying	Used with success

FIGHTER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
P-47 P-38 P-51	Anti-G suit for fighter pilots - a suit lined with a series of rubber bladders to control blood circulation in the face of severe gravity pull	July - October 1944	Pilots were greying-out or blacking-out at high speeds in fast pull-outs after steep dives	Made pilots more efficient by instilling in them more confidence in fighter planes - prevented black-outs in fast pull-outs
<u>SIGNALS & COMMUNICATION</u>				
P-47 P-51	Rosebud beacons installed in four aircraft of six different fighter groups for use as an airborne radar responder to Microwave Early Warning control	January 1945	To improve the range of fighter operation and identification by Microwave Early Warning control	Very successful for identification at extreme range. Helped to increase our fighter claims
P-51 P-47 & Reconnaissance aircraft	Tail-warning equipment installed in fighter and reconnaissance aircraft to warn of enemy's rear attacks	Fall 1944	To give warning of enemy's rear attacks	Installed in European Theater of Operations first; later put into production and used successfully by February 1945 in all fighter aircraft
<u>PERFORMANCE</u>				
P-47	Introduction of water injection kits, consisting of a water tank, pump and tubing, to inject a water spray in the P-47 engine (R-2800)	Late 1943	To allow greater manifold pressure, and hence greater powers to be used for short periods (15-20 minutes) during combat	The extra spurt of power accounted for many German airplanes and also saved many Eighth Air Force P-47s
P-47 P-38 P-51	Introduction of a new fuel, which was obtained by the use of certain additives to 100/150 standard grade fuel	Late 1944	To give our fighter aircraft the "edge" over the German Air Force grade 100/150 fuel	The fuel was entirely successful in operation but increased maintenance due to a tendency to cause lead fouling of spark plugs
P-47 P-51	150 pep fuel replaced 150 (MMA) fuel. The new fuel contained an additional $\frac{1}{2}$ theory of Ethylene Di-Bromide	Early 1945	To reduce the tendency of the 100/150 grade fuel to foul spark plugs	The new fuel was successful in that the tendency to reduce spark plug fouling was overcome, but it was discovered that the Ethylene Di-Bromide accelerated erosion of the valve seats of the Packard Merlin engine of the P-51

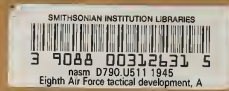
FIGHTER MODIFICATIONS

Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
P-47 P-51	The Command reverted to the use of 150 (MMA) grade fuel	Spring 1945	To prevent accelerated erosion of valve seats in the Packard-Merlin engine of the P-51	Experiments began in April 1945 on potential use of 115/145 grade fuel
P-47	Introduction of various jettisonable fuel tanks	February 1943- February 1945	To increase the range of fighter aircraft	
	a) 200 gallon, flat top, fibre belly with 4 point suspension			
	b) Superceded by the 108 gallon paper tank and modified rack, also suspended at 4 points			These tanks were used pending the arrival of P-47s from the United States equipped with the B-7 belly shackle
	c) The 108 gallon paper tank was hung on the B-7 belly shackle on a 2 point suspension beam			When the new type P-47s were received
	d) The standard United States 75 gallon metal belly tank used on the B-7 shackle			The auxiliary fuel system was then universalized to use either the 75 or 108 gallon tank on the P-47
	e) The 108 gallon metal tank, the 150 gallon metal tank, and the 210 gallon metal tank were also used, dependent upon the fuel capacity required			
	f) The 108 gallon paper tank was used for the purpose of external wing tanks			
P-38	The standard Lockheed 165 gallon belly tank was the equipment for P-38s in operations in this Theater			
P-51	The long range P-51, initially equipped with a 75 gallon metal tank made its debut as an escort fighter, and eventually replaced both the P-47 and P-51. Later it was equipped with either the 108 gallon metal or paper tank. Subsequently, this tank and its suspension were modified by using	1944		

FIGHTER MODIFICATIONS

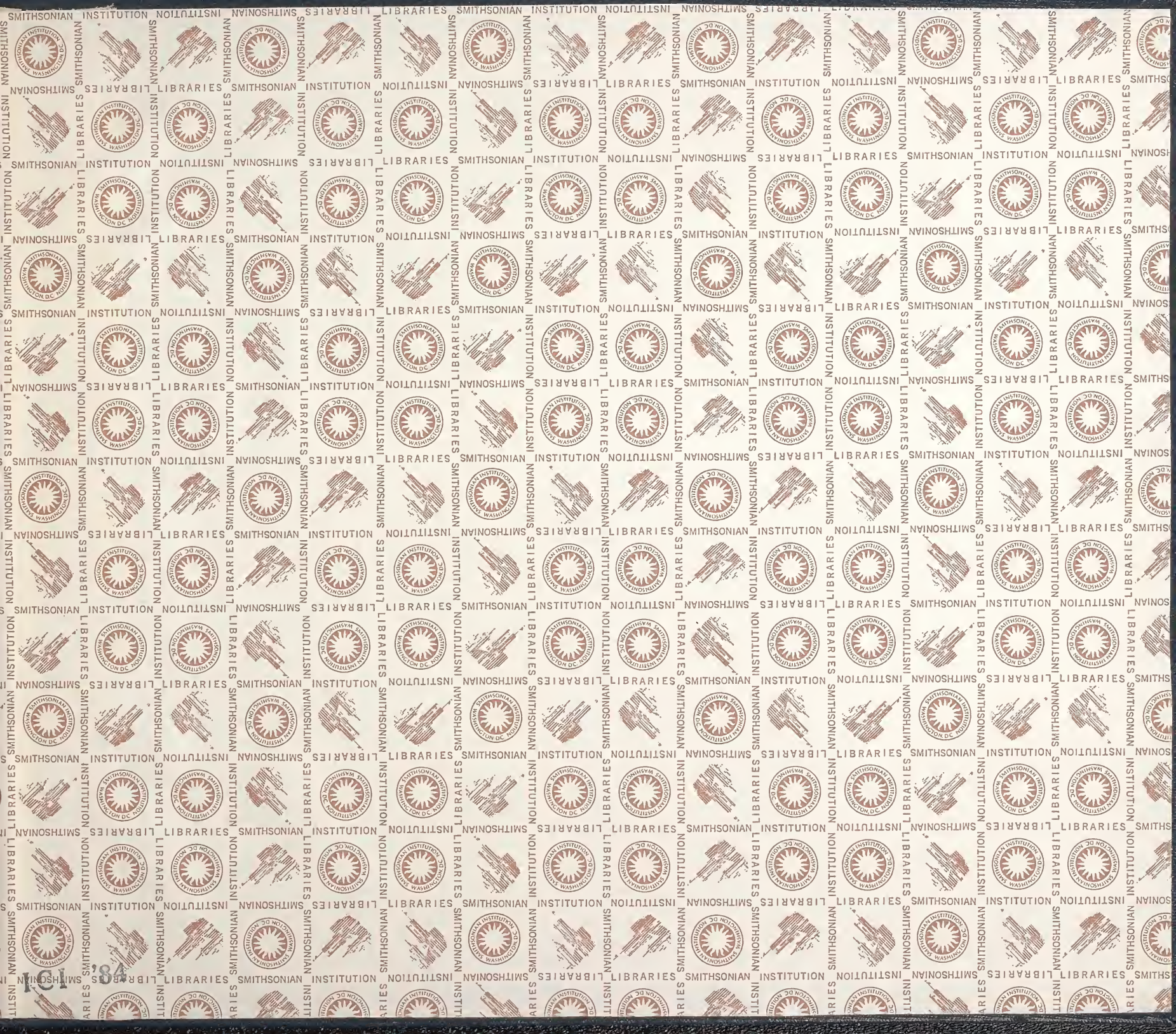
Type of Aircraft	Modification	Date Accomplished	Reason for Modification	Remarks
	a two-point suspension channel permitting the same tank and suspension to be used on either the P-51 or P-47. The 108 gallon tanks were later modified with front and rear outlets to make them useable on both the P-47 and P-51			
P-51	The new type P-51s came equipped with 2 x 115 gallon belly tanks, replacing 2 x 108 gallon tanks	February 1945		

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1945 tactical
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